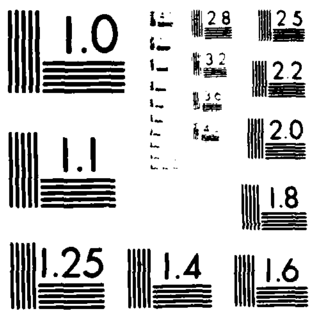
AD-A130 365   A DISTRIBUTED DATA BASE SYSTEM CONCEPT FOR DEFENSE TEST   1/1
AND EVALUATION(U) OFFICE OF THE UNDER SECRETARY OF
DEFENSE FOR RESEARCH AND ENG..  C K WATT MAR 83

UNCLASSIFIED   F/G 15/5   NL

END
DATE
FILMED
8-83
DTIC




MICROCOPY RESOLUTION TEST CHART

# A Distributed Data Base System Concept for Defense Test and Evaluation

# A DISTRIBUTED DATA BASE SYSTEM CONCEPT

# FOR

# DEFENSE TEST AND EVALUATION

Charles K. Watt

March 1983

CONTENTS


I Introduction

II The Decision Process

- o Descriptive Model of the Decision Process
- o Organizational Support Relationships
- o Planning and Assessment

III Tools and Technologies for Test and Evaluation

- o Utilization of Simulation Techniques
- o Definition of Simulation Techniques
- o Role of Each Simulation Technique
- o Current System Acquisition Trends
- o R&D Initiatives

IV Technology Implications

- o Trends in Information Transfer
- o Major Technologies
- o System Relationships

V Conclusions

Appendix

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

# REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

| | |
|---|---|
| 1. REPORT NUMBER | 2. GOVT ACCESSION NO. A130365 |
| 3. RECIPIENT'S CATALOG NUMBER | |
| 4. TITLE (and Subtitle) A Distributed Data Base System Concept for Defense Test and Evaluation | 5. TYPE OF REPORT & PERIOD COVERED Final Report |
| | 6. PERFORMING ORG. REPORT NUMBER |
| 7. AUTHOR(s) Charles K. Watt | 8. CONTRACT OR GRANT NUMBER(s) |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS Director Defense Test and Evaluation Washington, D.C. 20301 | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS |
| 11. CONTROLLING OFFICE NAME AND ADDRESS Office of the Under Secretary of Defense for Research and Engineering Washington, D.C. 20301 | 12. REPORT DATE March 1983 |
| | 13. NUMBER OF PAGES 43 |
| 14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) | 15. SECURITY CLASS. (of this report) |
| | 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |

16. DISTRIBUTION STATEMENT (of this Report)

Approved for Public Release; Distribution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

Approved for Public Release; distribution unlimited

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Distributed Data Base System, Test and Evaluation, Simulation, Decision Making, Problem Solving, Military Planning Procurement, Teleprocessing, Information Transfer, Weapon Systems

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The primary objective of test and evaluation in the Department of Defense is to support the acquisition of reliable and effective weapon systems for the operating forces. In accomplishing this objective, a methodology is required that builds on close coupling of the various testing activities and emerging technology. This paper describes these relationships and develops alternative system concepts that lend themselves to improving test and evaluation through utilization of new technology and techniques to transfer essential information in a more effective manner.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

## ABSTRACT

The primary objective of test and evaluation in the Department of Defense is to support the acquisition of reliable and effective weapon systems for the operating forces. In accomplishing this objective, a methodology is required that builds on close coupling of the various testing activities and emerging technology. This paper describes these relationships and develops alternative system concepts that lend themselves to improving test and evaluation through utilization of new technology and techniques to transfer essential information in a more effective manner.

## INTRODUCTION

Although Test and Evaluation (T&E) are firmly established as an integral part of the weapon system acquisition process in the Department of Defense (DOD), significant problems have historically inhibited its effectiveness.

Visibility is often given to cost, schedule, and performance problems associated with test and evaluation of weapon systems. However, the root causes of these problems have traditionally been overlooked in periodic sweeping reforms. In attempting to identify these causes, this writer did a survey and analysis of several major weapon system program assessments and associated decision guidance issued at key production decision points during the past three years. Dominant problems with common elements distributed across all programs were identified that required extensive corrective actions. A summary listing is presented below:

o Test planning was not timely and frequently objectives, goals and thresholds were either not well defined or not met during Operational Test and Evaluation.

o Due to late identification of major deficiencies, extensive Follow-on Test and Evaluation (FOT&E) was required to verify mission effectiveness and operational suitability. This resulted in conditional decisions at higher risk in approximately 74% of the programs reviewed. Reliability, maintenance, human factors, training, logistics, and software immaturity were dominant deficiencies identified in OT&E assessment reports.

o Considerable blurring of Developmental Testing and Operational Testing resulted in production decisions on hardware and software that were not representative of systems to be fielded; therefore, support was highly questionable.

o Inadequate resources were available for critical production transition periods due to limitations on reprogramming or built-in budget constraints.

Although test and evaluation are the common element in many of the above problems, this was not the root cause of these problems. A more indepth analysis coupled with personal participation in the process at both the Service and OSD levels, support the conclusion that inadequate planning and information flow were major contributors to these problems. Organizational structures and compressed schedules inhibited timely and meaningful communications between program management offices and the various hierarchical management structures within the defense establishment. This resulted in inefficient resource allocations, schedule restrictions, critical transition deficiencies and higher decision risks. The result of this dilemma was lack of quality T&E information (vice quantity) that defined in advance of essential decision points each weapon system's

operational effectiveness and suitability. Although major program review points were well known, the essential program objectives and supporting data required for executive level decisions were not clearly quantified in advance. Therefore, resource adjustments were not accomplished in a timely manner and most decisions rendered were conditional requiring extensive after-the-fact corrective actions. Essential to correction of this situation are early identification of critical test issues and quality horizontal data flows that closely couple critical events, resource allocations and reviews. Such an effort requires a more effective collection of data and more timely processing that accommodates the cognitive styles and judgemental heuristics of higher level decision makers. A detailed functional information flow with essential data elements identified must be developed as a first order of business. The results of this effort should provide order and structure necessary for subsequent development of a decision support system that could meet the increasing demands being placed on Defense test and evaluation.

## THE DECISION PROCESS

The decision process in the Office of the Secretary of Defense (OSD) utilizes highly structured procedures supported by many unstructured processes with primary inputs from the Defense Components. Therefore, contrary to the opinion of many who have a marginal outside perception or limited information, there are many variables that affect the effectiveness of these processes.

### Descriptive Model of the Decision Process

The policy and control procedures for major acquisitions are specified for reviews at critical transition milestones by various hierarchical

organizations within the Department of Defense. General problem-solving strategies are often used to deal with complex problems at these reviews with analogy, redefinition, alternative strategy, quantitative judgment and intuition among the many processes utilized in this form of decision making. Therefore, the cognitive style of decision makers is a fundamental factor influencing results. It is the contention of this author that such influence is significant and may be the most important factor in the decision process at the highest levels in the Department of Defense. At the OSD level, assessments by various staff experts, including the Director Defense Test and Evaluation, establish alternatives and recommendations that are provided to each member of a Defense Systems Acquisition Review Council (DSARC) prior to a comprehensive briefing by the program manager. Results of this council's deliberations are forwarded to the Deputy Secretary or Secretary of Defense for incorporation into a Decision Memorandum directed to the Service responsible for implementation. The traditional textbook models that appear to be similar to this process include the Anthony Taxonomy of strategic planning-management control-operational control, the "satisficing" process-oriented view, and the organization procedures view.

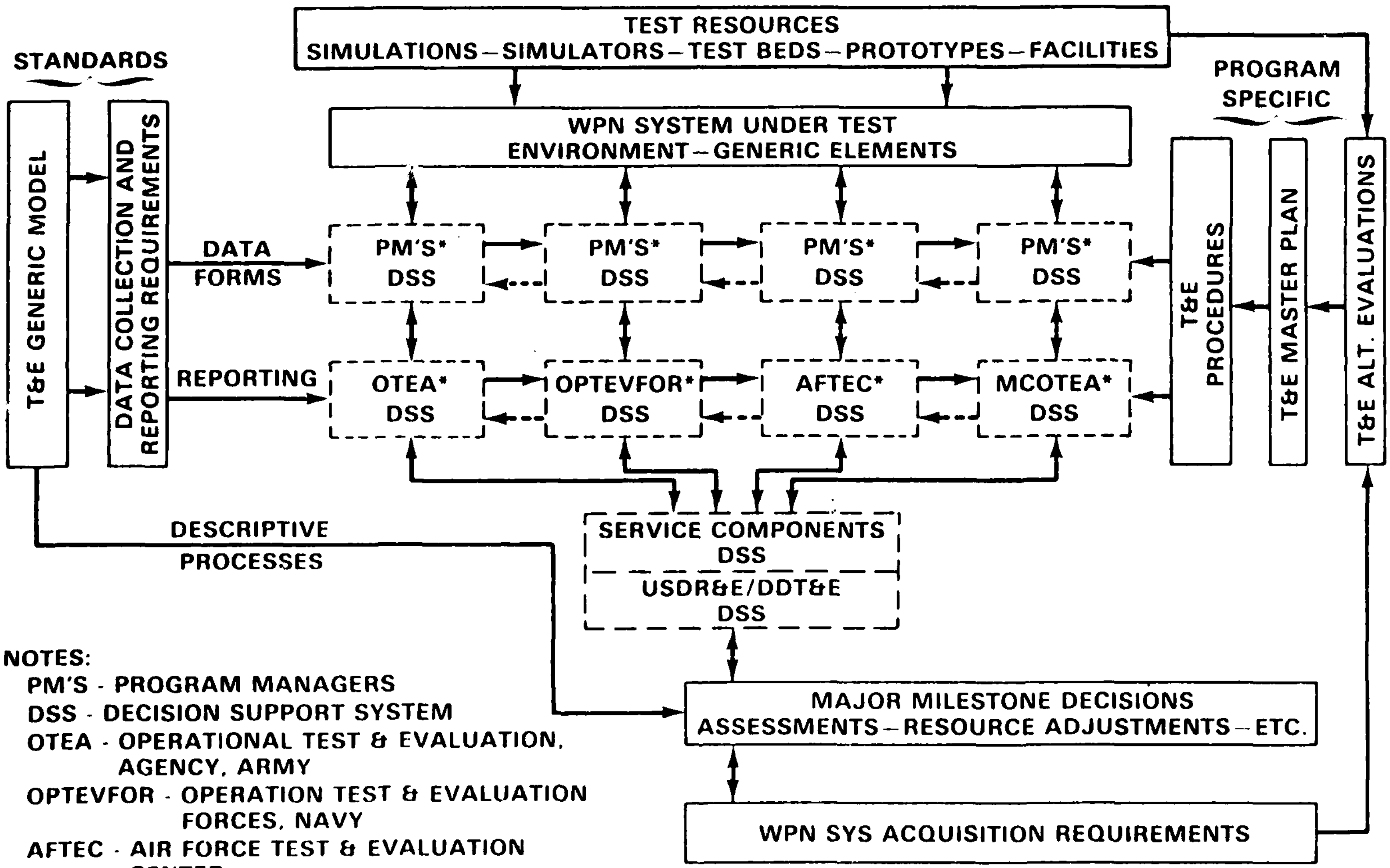
Test and evaluation often contain the most difficult set of variables impacting the weapon system acquisition decision process; therefore, its functional relationships form the core of the process description in this report. A draft proposal for a generic model of Defense Test and Evaluation is provided in Appendix 1. (The reader should review this appendix before proceeding.) Summary descriptions of policy, processes, associative functional diagrams and data forms are provided as the primary elements of this model, with essential functions directly supporting the

DSARC process being items 4.3, 4.7, 4.8, and 4.9. The most important parts of this model are the logic descriptions and data sets that can be utilized to establish standards for T&E processes and data collection activities. These are considered to be the essential components that support development of standards necessary for a T&E distributed data base system. Integration of these and associated decision support hierarchical systems are shown in Figure 1.

These T&E processes and associative acquisition relationships are considered to be basic building blocks required for a decision support system that can improve existing solutions and reduce bounds on rationality, organization roles and communication channels. Such processes should utilize a taxonomy of decision rules integrated into the Bonczeks, Holsapple, Whinston generic descriptions for decision support. A functional sample of the DSS suggested for Service Independent Test Activity and DDT&E is shown in Figure 2. Such systems would be computer-based for management decision makers who are dealing with semistructured problems. They should provide support for users at different levels in all phases of the decision-making process on a hierarchical relational basis. Particular attention must be given to the language system to simplify user computation and data retrieval but not limit possible artificial intelligence structuring techniques. Obviously these descriptive processes require considerably more attention to detail and analysis; however, they are considered to form the conceptual framework for a feasibility study. Suggested steps for this feasibility study are as follows:

- Gather facts on T&E agencies and DDT&E
- Identify cross-Services commonalities
- Validate and refine Appendix 1 generic model of T&E

# T&E PROCESSES AND DECISION SUPPORT RELATIONSHIPS




NOTES:
- PM'S - PROGRAM MANAGERS
- DSS - DECISION SUPPORT SYSTEM
- OTEA - OPERATIONAL TEST & EVALUATION, AGENCY, ARMY
- OPTEVFOR - OPERATION TEST & EVALUATION FORCES, NAVY
- AFTEC - AIR FORCE TEST & EVALUATION CENTER

* GEOGRAPHICALLY DISPERSED ACTIVITIES. SEE FIG 2 FOR SAMPLE DSS

FIGURE 1.

# FUNCTIONAL SAMPLE DECISION SUPPORT SYSTEM (DSS)

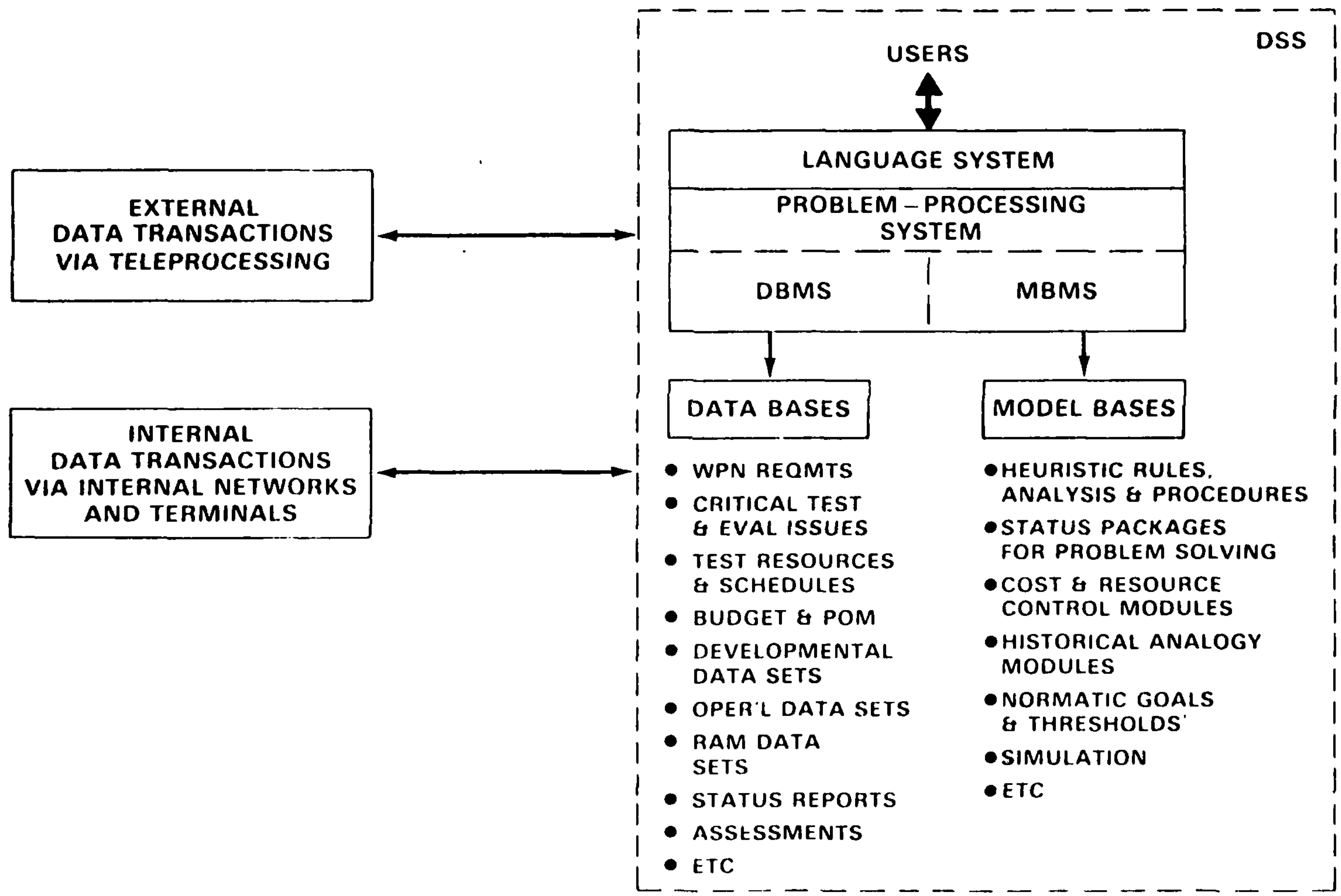


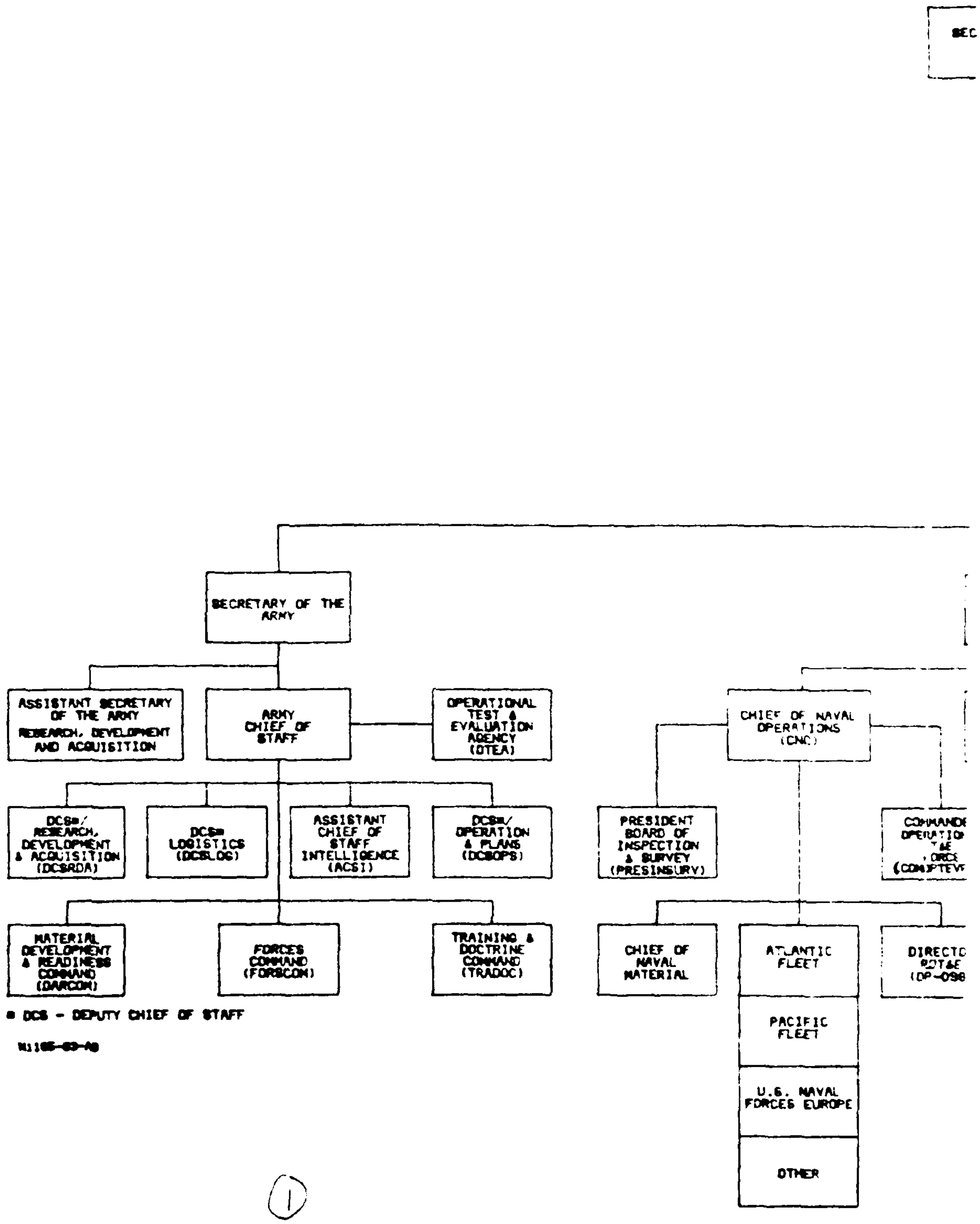

FIGURE 2

- o Develop hierarchical flow charts
- o Assess the feasibility of a DSS prototype at a Service Independent Test Agency or Joint Test Activity
- o Develop an implementation plan

Also incorporated into this study must be key variables that would influence implementation. Lucas in his earlier book (1976) on "The Implementation of Computer-Based Models" lists these and describes their relationships. His later book (1981) on "Implementation: The Key to Successful Information Systems" gives very good examples on application of "Lewin Force Field" analysis and a comparison of design activities with critical factors. This study must also be closely coupled with the research and development initiatives described in the tools and techniques for T&E section of this report. Key to effective implementation of a T&E automation concept is connectivity to relational data bases at each of the Services' Independent Test and Evaluation Agencies.

Organizational Support Relationships

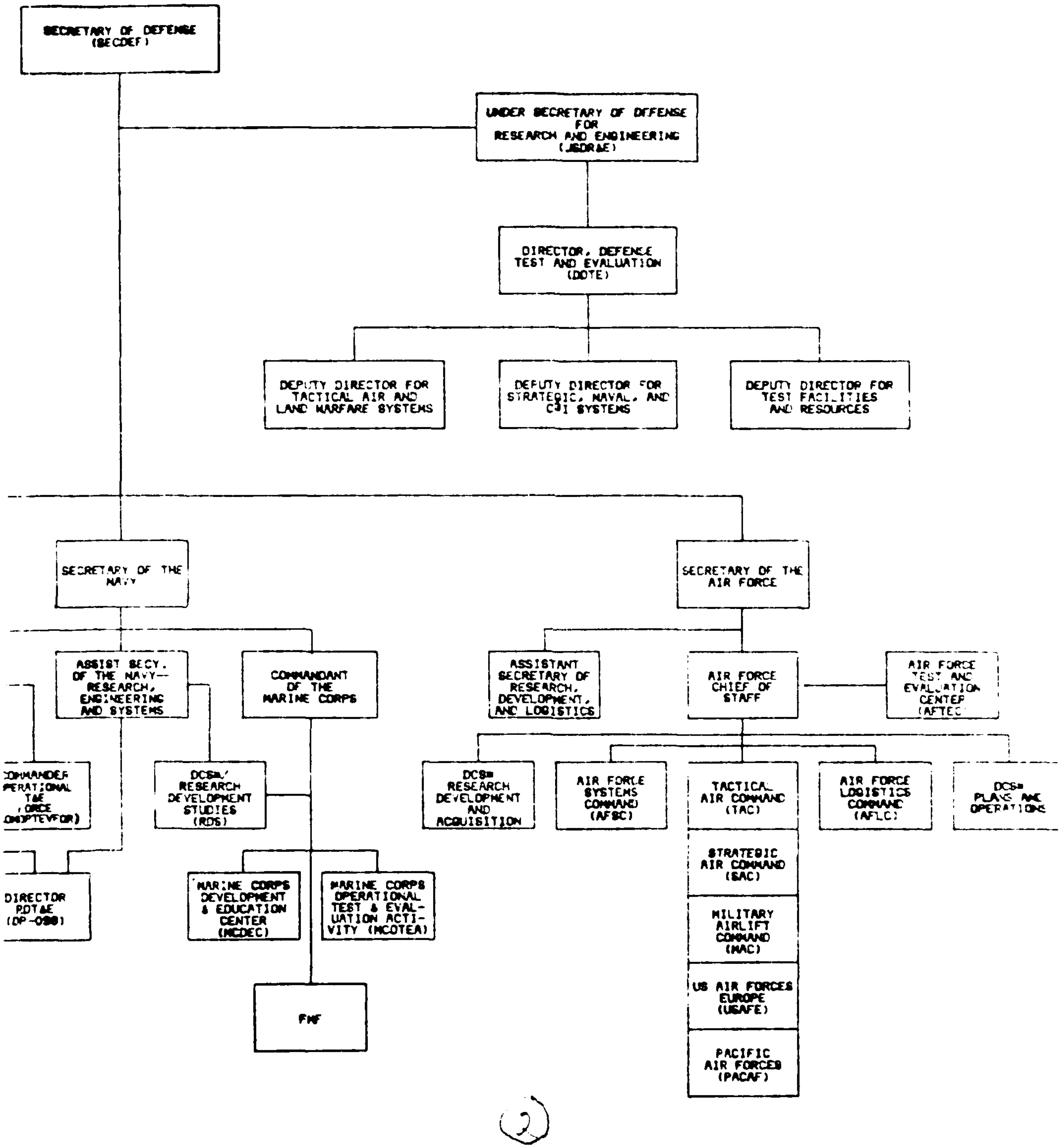
As indicated in Figure 3, test and evaluation has been firmly integrated into the Department of Defense management structure. However, as indicated in the introduction of this report processes to determine weapon systems operational effectiveness and suitability must place more emphasis on establishment of critical test issues and evaluation criteria during the early stages of the acquisition cycle. This requires that testing methodology and instrumentation provide a mature and flexible network of resources that stress weapon systems in a variety of environments. Therefore, traditional lines of demarcation between the developer, tester, and user must be modified to provide positive associative relationships that increase the potential for achieving more realistic testing conditions. Such




* DCS - DEPUTY CHIEF OF STAFF

N1165-83-A8

DoD Managemer




g-ment Structure for Test and Evaluation

FIGURE 3

close coupling of test activities provides conditions favorable for utilization of common test documentation data bases as programs progress through the various acquisition phases. In support of this concept, considerable attention must be given to software verification and more attention given to coordinated utilization of simulation, testbeds, and prototypes in the acquisition process. These activities linked with technology advances during the next several years are expected to provide unique opportunities for improving test and evaluation, while at the same time presenting many transition challenges. Essential to effective implementation of test and evaluation policies are the procedures and organizational support provided by the Services. These organizations must provide the resources and commitment to principles required for the Director Defense Test and Evaluation to effectively support major program decision milestones. Basic test and evaluation principles currently being emphasized to accomplish these objectives include:

o Initiation of Development Test and Evaluation (DT&E) and Operational Test and Evaluation (OT&E) early to identify and reduce risks and estimate operational potential.

o Establishing critical issues, test objectives and evaluation criteria well before testing begins and ensuring that these are related to the mission need.

o Gathering of sufficient test data with appropriate test instrumentation to minimize subjective judgements.

o Conduct of OT&E by Service test agencies independent of the developer and user.

Although current policy states that successful test and evaluation are required for a decision to commit resources or advance at milestones

established for key acquisition phases, too many programs are now requiring conditional decisions. This has forced after-the-fact adjustments in programs and committed the T&E community to lengthy schedules that seriously impact limited resources. This situation is compunded in that Service independent test agencies are also beginning to get actively involved in the early phases of the acquisition process. Space and Cruise Missile programs are examples of such involvement that have attempted to expedite acquisitions by combining significant phases of development and operational testing. In these situations, the credibility of testing must be maintained and quality independent test and evaluation reports submitted prior to major decision milestones. Such procedures are essential and must be included in test planning to minimize data biases that distort decisions.

Planning and Assessment

Planning is most important for timely establishment of procedures that will provide an effective test and evaluation program. The document that is utilized to describe such planning in DoD is the Test and Evaluation Master Plan (TEMP). Contents of this document for major weapon systems include:

- Mission and system description
- Required operational and technical characteristics
- Critical T&E issues
- Management responsibilities
- DT&E/OT&E expected or actual results
- Production acceptance T&E
- Test articles and special support requirements.

For programs requiring Secretary of Defense (SECDEF), Deputy Secretary of Defense (DEPSECDEF), or Under Secretary of Defense for Research and

Engineering (USDR&E) decisions, the Director Defense Test and Evaluation (DDT&E) must approve the TEMPs and provide an assessment of the weapon systems' operational effectiveness and suitability. Assessments require utilization of a variety of analysis techniques with TEMP's forming the primary benchmark criteria for test and evaluation reporting by Service Independent Test Agencies and program managers. Such comparison of measured results from operationally realistic tests with clearly defined requirements has historically proven to be an effective means of quantifying program risks. A simplified listing of typical weapon system elements included in T&E is presented in Figure 4.

## TOOLS AND TECHNIQUES FOR TEST AND EVALUATION

Major weapon systems in the Department of Defense take a variety of forms with designs that range from mostly software systems to mostly hardware systems. Therefore, developers and testers of weapon systems utilize a multiple of techniques to validate performance of subsystems and systems as programs progress through various stages of acquisition. Recent emphasis on compressed schedules and greater complexities are forcing more attention to utilization of simulation techniques to demonstrate performance during early stages of weapon system developments. Since deployment environments are difficult to duplicate, almost any testing done can be considered some form of simulation. Such simulations can be very realistic, as in operational testing of production systems, or they can be very abstract, as in development testing of computer models.

# GENERIC DEFENSE WEAPON SYSTEMS TEST AND EVALUATION ELEMENTS

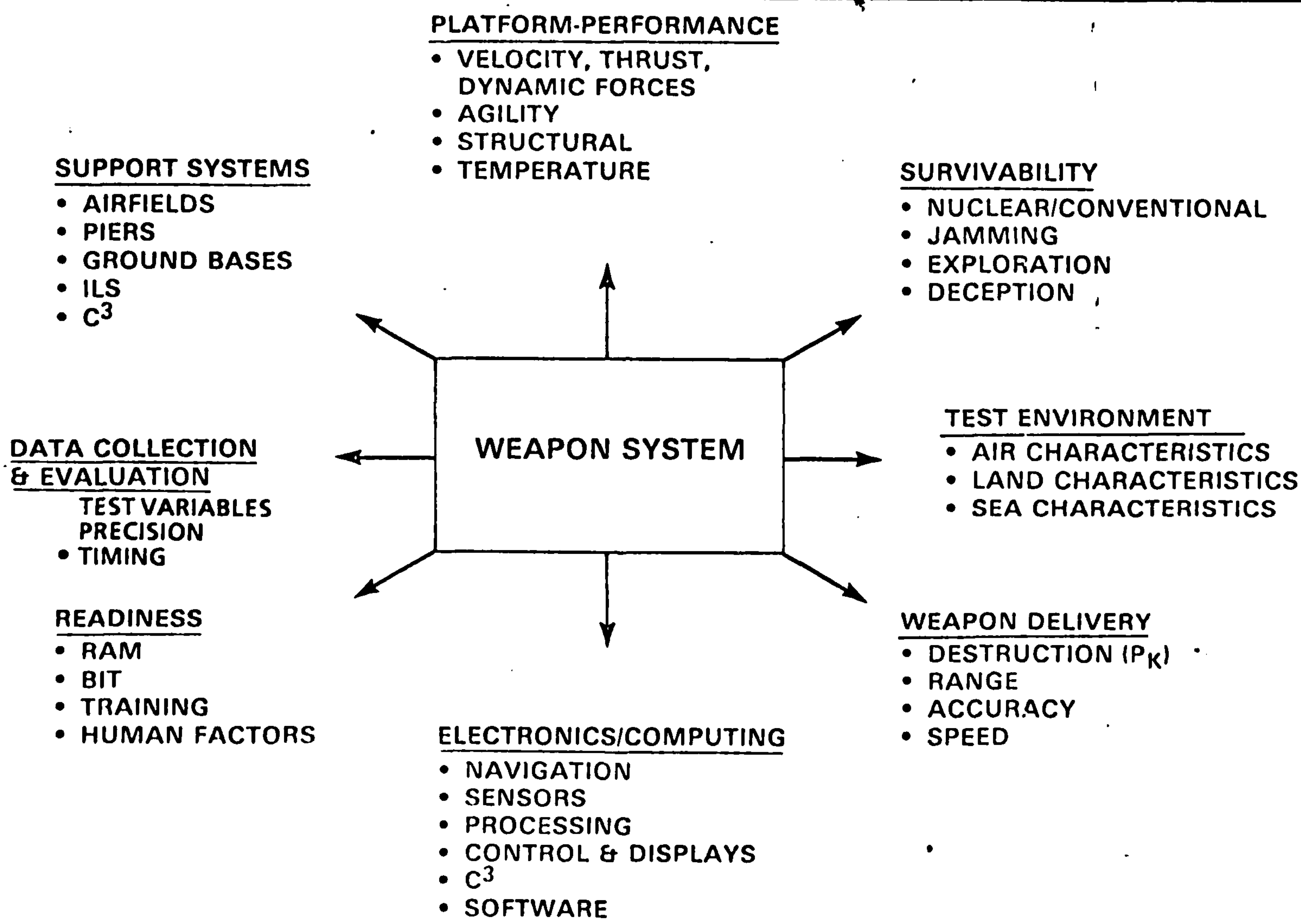



FIGURE 4

Utilization of Simulation Techniques

Early testing of system characteristics and specific subsystems usually require utilization of some form of simulation techniques. Therefore, more effective utilization of models, test simulators, and test measurement techniques is essential if testing complexity and costs are to be kept under control. The establishment of permanent testbeds for this type of testing is possible and certainly appropriate if they can be used on a recurring basis. Even though simulators and testbeds may not, in all cases, accurately project operational suitability characteristics in absolute terms, they are extremely useful in showing the relative impact of deficiencies, quantifying risks and identifying critical issues. Close coupling of realistic field testing with simulators and testbeds is an essential technique for improving test accuracy. This type of testing provides the developer and user with alternatives for support in a dynamic and interactive manner.

Definition of Simulation Techniques

For purposes of simplification, three distinct types of simulations are identified for test and evaluation: (1) computer simulations, (2) system testbeds and (3) system prototypes. The distinguishing feature of computer simulations is that they are strictly mathematical procedural representations of systems and do not employ any actual hardware. They may, however, incorporate some of the actual software that might be used in a system. The digital computer simulations used to generate performance contours for air-to-air missiles are examples of this class of simulation. The second generic type of simulation is the system testbed. A system testbed usually differs from a computer simulation in that it contains

some, but not necessarily all, of the actual hardware that will be a part of the system. Other elements of the system are either not incorporated or are incorporated in the form of computer simulations. The system operating environment (including threat) may either be physically simulated, as in the case of a flying testbed, or it may be computer simulated, as in the case of a laboratory testbed. Aircraft cockpit simulators used to evaluate pilot performance are good examples of system testbeds. The third type of simulation used in test and evaluation is the system prototype. Unlike the system testbed, all subsystems are physically incorporated in a system prototype. The system prototype may come arbitrarily close to representing the final system configuration, depending on the state of development of the various subsystems which compose it. Preproduction prototype missiles and aircraft used in operational testing by the Services are examples of this class of simulation. It should be recognized that the distinctions made between the three generic types of simulation can often become blurred. A system testbed, for example, which incorporates most, but not all, of a system's hardware components can come very close to representing a system prototype. On the other hand, a system testbed that incorporates only one or a few hardware subsystems, with the rest being simulated, takes on many of the characteristics of a computer simulation. There is, therefore, a continuous spectrum of simulation types with the pure computer simulation at one end and the pure hardware prototype at the other end, as shown in Figure 5.

## Role of Each Simulation Technique

Each of the three generic types of simulation has various advantages and disadvantages depending on the rating criterion being considered.

# APPLICATION OF SIMULATION TECHNIQUES IN SYSTEM EVALUATION

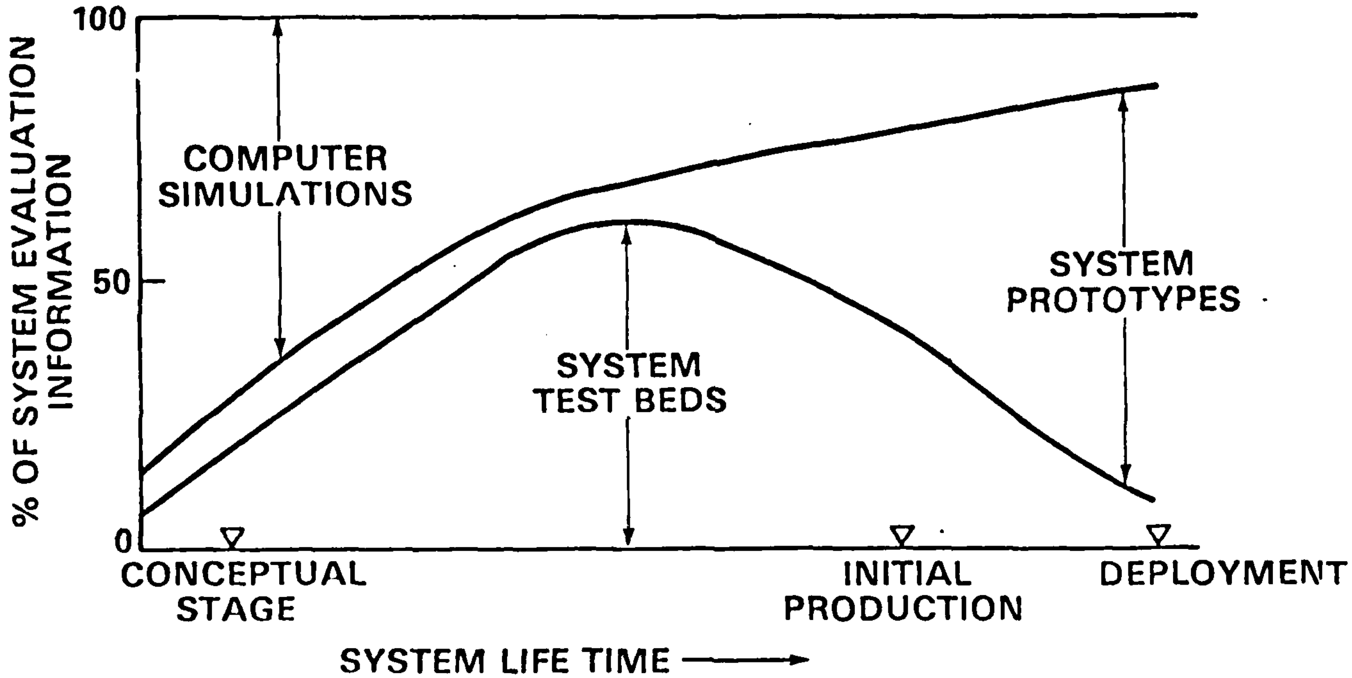



FIGURE 5

1. Availability

Early in a system's life cycle, computer simulations can be expected to provide the most system evaluation information. As development of a system progresses, more and more subsystems become available in hardware form and eventually all subsystems will become available for incorporation in one or more system prototypes. Operational testing of these prototypes frequently provides much of the system evaluation information needed for a decision on full scale production and deployment. Subsequently, more representative initial production prototypes will become available for testing to verify correction of deficiencies, investigate evolutionary improvements, develop tactics, etc.

2. Realism

A second important factor of interest is the degree of realism offered by various simulation techniques. Realism is important because the validity of the results obtained from a simulation is directly related to how realistically the simulation represents the system and its environment. In general, prototype testing in an environment physically representative of combat provides the greatest amount of realism of the three simulation techniques. Testbeds and computer simulations provide respectively less realism. However, there are exceptions to this rule. A computer model, for example, can sometimes more realistically represent the enemy threat in those cases where physical simulations of the threat are not available for prototype testing. Also, a computer simulation can frequently provide a more realistic representation of casualty effects than can prototype testing. In most cases, however, prototype testing will be the most realistic simulation technique available.

3. Believability

Closely related to the realism factor is the acceptance or believability of results obtained from simulations. Decision makers will usually feel more confident about system evaluation data obtained from hardware prototype testing than that from a computer simulation. It is generally much easier to mentally extrapolate from a realistic prototype test of expected combat performance than it is from a computer simulation. Obtaining a high level of confidence in the results of a computer simulation normally requires a detailed understanding of the assumptions and analytical procedures used in constructing the simulation. Acquiring such an understanding takes more time and effort than is available to most decision makers. In many cases, the believability of computer simulations can be greatly enhanced when these simulations have been validated by corroboration with results from realistic physical testing.

4. Cost

The cost of computer simulation will usually be much less than that of physical testing, particularly where destructive testing of prototypes is involved. A live warhead firing of a prototype air-to-air missile against a realistic full scale target on an instrumented range could involve millions of dollars of direct and indirect costs. The same missile launching carried out on a computer simulation would be an order of magnitude less costly.

5. Time of Execution

Computer simulation holds the same advantage over physical testing when it comes to time of execution. Again, consider the case of an air-to-air missile. Since an air-to-air missile operates in three dimensional airspace, there are an extremely large number of altitude differentials,

speed differentials, aspect angles and launch ranges that should be considered in assessing its effectiveness. Any attempt to physically test the missile over any reasonably representative sample of tactical situations would be time consuming, not to mention expensive. Simulating these cases on a high-speed digital computer, however, could be accomplished in a relatively short time.

6. Control

Another factor in evaluating simulation techniques is the degree of control that can be exercised over relevant variables. Here, there are two aspects to be considered. In one case, all variables may be rigidly controlled to isolate the effects of one particular variable. In a digital computer simulation it is, of course, very easy to control all variables. In prototype testing, and particularly prototype operational testing, it is much more difficult. This is due partly to the sometimes unpredictable behavior of men, machines and the environment, and partly to the inability to measure adequately all variables that affect the outcome of the test.

7. Free-Play

The second aspect of variable control that should be considered is the amount of free-play permitted by a particular simulation. In a computer simulation free-play, if any, is limited to those elements designed into it by the programmers. In operational testing of prototypes, however, a great deal of free-play can be introduced by allowing players to react to situations in a manner that each perceives to be optimal. The benefit of free-play is that it can expose problems not predicted in designing a system or constructing a computer simulation. As an example, free-play testing can reveal unexpectedly effective enemy countermeasures or expose very low reliability in systems that were previously thought to be highly

reliable. Figure 6 shows a comparison of the three generic types of simulation for each of the above evaluation factors. Computer simulations and system prototypes will usually be either best or worst for each factor considered with system testbeds somewhere in between. What is not obvious from comparing the advantages and disadvantages of each individual simulation technique is the synergistic effect that will usually result from employing all three of these techniques. For example, computer simulations can be used to pinpoint critical performance zones that should be explored by physical testing of testbeds and prototypes. This can greatly increase the economy and efficiency of physical testing. On the other hand, results of physical testing can be used to validate computer simulations, thereby increasing their accuracy and believability. Once validated, computer simulations can be used to extrapolate the results of physical testing to cover a great many more scenarios and engagement situations, than would be possible from physical testing alone. The end result of these synergistic effects is that the value of using a combination of the three types of simulation techniques can greatly exceed the value of using any single one.

<u>Current System Acquisition Trends</u>

There are several trends in system acquisition policy currently influencing DoD decision techniques.

1. <u>Shorter Acquisition Cycle</u>

One of the more significant trends has been an increased emphasis on shortening the acquisition cycle. Shortening the acquisition cycle has two important implications. First, it reduces the length of time available for obtaining system evaluation data. Second, it requires that quality system evaluation data be made available earlier in the

acquisition cycle. Requiring system evaluation data earlier in the acquisition cycle likewise implies a greater emphasis on computer simulations and system testbeds versus system prototypes. This is the case because computer simulations and system testbeds will normally become available much earlier in a system's development cycle than will system prototypes. Computer simulations can be developed from basic preliminary design data and extrapolations from computer simulations of similar predecessor systems. Representative prototypes, on the other hand, will not normally become available until system hardware development is virtually complete. Therefore, conducting prototype testing will usually involve extensive planning, preparation, training and set-up time. In addition, if only one or a few prototypes are available, test replications have to be conducted in series. By contrast, multiple test replications on a computer simulation can be achieved in much less time and with a minimum of lead time.

2. Increasing System Cost

The increasing cost of weapon systems is another trend affecting the use of simulation to obtain system evaluation data. As the capabilities of our ships, aircraft, missiles and other weapon systems have increased over the years, so have their development and procurement costs. The result has been to increase greatly the cost of prototype testing, particularly destructive prototype testing. The cost of computer simulation has also risen over the years, but not nearly as much because of the technological and programming efficiencies introduced in the computer field. The net result is that, as cost containment priority increases, more emphasis is placed on computer simulation to quantify risks.

3. Increasing Complexity

Increasing complexity is another trend that must be considered. The increasing capabilities demand of our weapon systems have required ever-increasing sophistication and complexity in their design. The situation is compounded for the test and evaluation communities by complex threats and the difficult environments in which they must operate. Increasing complexity makes it much more difficult to predict how a system will perform against the threat in an operational environment. This argues for realistic field testing of prototypes, which is frequently the only way to ensure proper consideration of the multitude of factors that impact the performance of a modern weapon system.

Research and Development Initiatives

Looking toward future use of simulation techniques, DDT&E has initiated research to determine the feasibility of networking geographically dispersed systems. If these new initiatives are successful, several important T&E benefits may result, including:

o The ability to simulate increasingly complex systems and scenarios.

o Reduced time and cost associated with the acquisition of new systems through multiple and repetative use of test facilities.

o Increased confidence on the part of decision makers due to increased realism in the simulation.

Interdependent simulations must be able to exchange information in a timely manner and the amount of information that must be exchanged may be quite substantial. The emerging technology of wideband communications makes the transmission of large volumes of information more attractive. However, this technology does not eliminate many of the historical problems such as communication delays and information security associated with both satellite and terrestrial microwave links.

In recognizing these potentials and associated problems, we are attempting to develop a set of guidelines for interconnected, geographically distributed simulations of the previously described generic types. This effort can serve as the basis for a future demonstration effort. To achieve this goal, we have established the following specific objectives:

o Identification of classes of simulations for which distribution of parts of the simulation would be advantageous

o Delineation of the implication of new computer and communications technologies as related to geographically distributed simulations

o Development of a preliminary design description for networking simulations

o Application of the design guidelines including standards, to determine the feasibility of interconnecting specific simulations.

o The implementation of a database management system to catalog information on available models, data, hardware specifications, and testbed architectures.

Different systems within the Department of Defense will be analyzed as possible candidates for inclusion into geographically distributed simulation networks. These simulations will be categorized along several dimensions and technological advances expected to influence successful construction of geographically distributed simulation networks. Alternatives will be examined to assess the impact of advances in hardware, software and communication technologies.

Some joint test programs are also attempting to connect geographically dispersed simulation facilities. For example, the Identification Friend, Foe or Neutral (IFFN) joint test has been established to evaluate the capability of the current NATO Air Defense System and proposed modifications

to assist in the identification of airborne targets. The IFFN joint test will use a distributed network in which various simulation, test and operational facilities across the country are linked together on a realtime basis through a central computer facility.

The Department of Defense appears to be moving toward greater use of simulation techniques in its decision making. This trend is becoming especially pronounced in the Command, Control and Communications (C3I) area, since simulation techniques can be readily applied to the teleprocessing technology and doctrine employed by C3 systems. However, limited advances have been made in "use of distributed simulation". Essential to future success is closer coupling of simulation facilities and functions. An architecture with selectable centralized control and distributed operation is certainly a feasible, worthwhile objective. A distributed C3 test bed using already-developed simulations and facilities in place could well become a national asset that could be used for test and evaluation of individual service or joint programs.

## TECHNOLOGY IMPLICATIONS

Closely linked to all the previously described possible improvements in T&E are the technologies available for transfer, storage and processing of information. Although such technologies span a large spectrum, only those expected to be major drivers within the next few years will be discussed in this report.

### Trends In Information Transfer

The information society is rapidly becoming a reality as microelectronic computers and other electronic disciplines provide unprecedented universal wideband networks. Along with this evolution, the meshing between computer

and communication equipment has become so pervasive that communication specialists have coined new words such as "compunications," "telematique," "telematics" and "teleprocessing."

The term "teleprocessing" utilized in the context of this paper is defined as the combined use of communications facilities and data processing equipment. Dominant among the many elements supporting this definition are (a) technological advances that have tended to blur traditional lines of demarcation between communications and processors and (b) recent judicial decisions rendered in cases such as IBM and AT&T. Technology during the next several years will continue to support such transparency as teleprocessing services become more widespread. The major inhibitor to such growth is the scientific limitations in software development.

Major Technologies

The technologies that have already induced major changes in teleprocessing systems are very-large-scale integration (VLSI) circuits, digital techniques, satellites, and optical fibers. Transition of these technologies has and will continue to take many forms as various elements are designed to provide reliable and timely teleprocessing services in a cost effective manner over networks consisting of both space and terrestrial systems. The driving force behind this change is the enormous demand for economical information transfer services. The impact of the microelectronics revolution on these services is just beginning to be felt with computing hardware costs dropping sharply. The widespread utilization of the microprocessor is due to the fact that it is inexpensive hardware and can be programmed to perform an unlimited variety of tasks. This permits more and more software to be written for more and more embedded computer applications. However, this has created a significant delima

in that software continues to be more of an art than science and is considered to be a major contributor to increased risk in almost all systems. Such is the case in both commercial and defense systems with embedded computers already becoming a dominant element of the total system investment and software a significant factor in performance deficiencies and cost increases.

Integrated circuits have already induced major changes in weapon system developments and testing techniques and will continue to do so during the next decade. Wafer size is increasing, allowing for greater increases in the number of devices that can be produced on a single chip. As chips get larger and density increases, a new generation of integrated circuits will be possible with one million devices on a single chip now considerd to be within reach and one billion components per chip being discussed as possible in the future. The amount of memory on a single chip has been quadrupling every two years and is expected to continue with chips containing 8 to 32 megabites of memory within the next decade. Sixty-four kilobit random access memory chips are now being shipped in volume. The small size, high reliability, and low power consumption of these components make them suitable for numerous test and evaluation applications. New logic inside future chips will increase the speed of microprocessors and the large number of functions on a single chip will also greatly increase microprocessor design options. Programmed with high level languages, systems will feature minicomputer-like architectures and powerful instruction sets which will allow written software to be executed in any location of the microcomputer's address map.

Implicit in these developments is the continually increasing importance of software that is embedded in the computer's architecture. Essential

to improvements in software testing is the early involvement of the testing community in the development cycle. Such involvement permits all software life cycle activities to be evaluated in a timely manner parallel to hardware and assists in ensuring that software specifications and testing include performance, reliability and implementation considerations. This integrated approach is expected to have high payoff in the future with significant reductions in endpoint testing problems. The introduction of microprocessors has already permitted major advancements in instrumentation and test methodology. For example, technology now permits test data to be collected on a distributed realtime basis and automatically relayed to a central computer that has built-in software routines for a rapid analysis and display of results. Test and diagnostics on many small systems are now being handled automatically on a routine basis. However, large software systems continue to present problems.

Progress in low-loss optical-fiber technology and integrated circuits is providing a new generation of digital transmission systems. Such progress is a vital part of the move toward time-shared digital networks. Advances in both terrestrial and satellite systems are also making important contributions to the development of an integrated network with transmission speeds varying from a few kilobits per second to hundreds of megabits per second. As a result of these improvements, networks have the potential of becoming universal translators of signals with transparent interfaces.

System Relationships

The interaction of telecommunications and computing into a new teleprocessing form of service has placed new demands on the proess of achieving point-to-point communications effectively and efficiently. Connection of direct electrical channels between terminals, typical of

telegraphic or telephonic services, has been augmented by methods of assigning time intervals, or time slots, on a single channel to subscribers on demand. The time assignment method of networking is a feature of emerging satelite-based systems and packet switching systems.

Networks must be able to interact with a multiplicity of voice digitization techniques, digital data techniques and analog techniques. Transmission rates must be accommodated ranging from kilbits per second to megabits per second. Services, such as low speed video and facsimile, currently practical almost solely via dedicated circuits, must be integrated on a system basis. Data communication system must be able to handle interactive, query/response, data base update, and bulk data traffic interchangeably and efficiently. The systems must provide adaptability for the efficient use of trunk capacity for a wide variety of transmission characteristics covering a wide range of transmission rates. They must be compatible not only with established communications links (wireline, line-of-sight radio, satellite radio) but also new communications links based on techniques such as time division multiple access satellite and various types of microwave and optical links. They must be capable of maintaining link and large scale network sychronization with practical networks incorporating such factors as expandability, modularity, availability, and interoperability as well as being economical in transmission costs by utilizing transmission capcity efficiently. A wide variety of differing terminal types will be utilized with transmission rates ranging from hundreds of bits per second to hundreds of kilobits and transaction sizes ranging from several hundred bits to millions of bits of data.

Wideband networks have the potential for providing a new dimension to test facility utilization with direct connectivity permitting more

synergistic relationships. The TRI-TAC Communications Test Facility at Fort Huachuca, Arizona, and the Command, Control and Communications Systems Integration Test and Evaluation Site at the Naval Ocean Systems Center, San Diego, California, are examples of test facilities attempting to utilize such networks. These facilities assist in filling the gap between the developer and the user by providing interoperability on a multi-system, multi-platform basis. As previously indicated, Joint Test programs are also being designed to carry this concept even further with a test bed now being designed to conform to a centrally controlled distributed architecture. A computer network can also provide a basic framework for developing and connecing geographically dispersed simulation facilities. The network should be thought of as a delivery service that guarantees the timely delivery of information between sites served by a shared switched system vice dedicated circuits. Prior to effective implementation of such a system, numerous issues such as simulation component differences, interfaces and communications medium constraints must be resolved.

## CONCLUSIONS

Inadequate planning and information flow are identified in this report as major contributors to T&E associated acquisition problems. In order to assist in correcting this situation, a concept is developed for an integrated T&E Decision Support System. This concept envisions an effective and timely processing of data accommodating the cognative styles and judgemental heuristics of decision makers. It is the contention of this author that such influences may be the most important factor in the decision process at the higher levels in DoD.

A draft proposal of a generic model is provided as an appendix to this report. These T&E processes and associative acquisition relationships are considerd to provide essential building blocks required for a DSS. Such effort must also include more effective utilization of test resources, i.e., computer simulations. Much of the differentation that has historically inhibited T&E effectiveness could possibly be neutralized with the concepts and techniques suggested. These concepts are considered to be in full support of acquisition trends in DoD and within state-of-the-art technology.

Bibliography

1. Keen, Morton, Decision Support Systems: An Organizational Perspective. Addison-Wesley Publishing Company, Inc., 1978.

2. Bonczek, Holsapple, Whinston, Foundations of Decision Support Systems. Academic Press, 1981.

3. Lucas, The Implementation of Computer-Based Models, 1976.

4. Lucas, Implementation: The Key to Successful Information Systems, 1981.

5. Tsichritzis, Lochovsky, Data Base Management Systems. Academic Press, 1977.

6. Myers, Isabel, Gifts Differing. Consulting Psychologists Press, Inc., 1980.

7. Puritano, Vincent, "Getting Ourselves Together on Systems Acquisition," Defense Management Journal, (October 1981), pp. 9-19.

8. Borklund, C.W., "Defense Systems Acquisition: What The Pentagon is Doing to Make It Better," Government Executive, (--1982), pp. 22-26.

9. Brabson, Dana G., "The DoD Acquisition Improvement Program," Concepts-The Journal of Defense Systems Acquisition Management., Vol. 4 No. 4, pp. 54-75, Autumn 1981.

10. Department of Defense Report, "Acquisition Improvement Task Force," December 1981.

11. Clemson University Report, "Simulation Network For Test and Evaluation of Defense Systems: Phase I Survey of DoD Testbed Requirements," 1983.

APPENDIX

# GENERIC MODEL OF DEFENSE TEST AND EVALUATION

A model that specifies the policies, processes and summary data requirements from independent test activities and development communities would assist in improving the information flow and be a major contributor to increasing the effectiveness of the acquisition process for major weapon systems. Such an approach should assist in reducing the time to complete the acquisition process. However, closely coupled with this model must be the establishment of distributed data bases that can be selectively utilized by the development and testing communities. Equally important is incorporation of these factors in plans developed during early phases of the acquisition cycle. Such planning, when placed in perspective with a balanced testing program, can be an effective tool to assist in solving the critical issues that are precluding vital improvements in the performance and operational readiness of our deployed forces. More effective advanced planning and budgeting would also permit a more timely and synergistic utilization of simulators, test beds and prototype equipments throughout the acquisition cycle. Such an approach is essential for large multiple-mission platforms that must be developed over an extended period of time.

# DIRECTOR DEFENSE TEST AND EVALUATION

MISSION: Manage Department of Detense Test and Evaluation (T&E) Activities

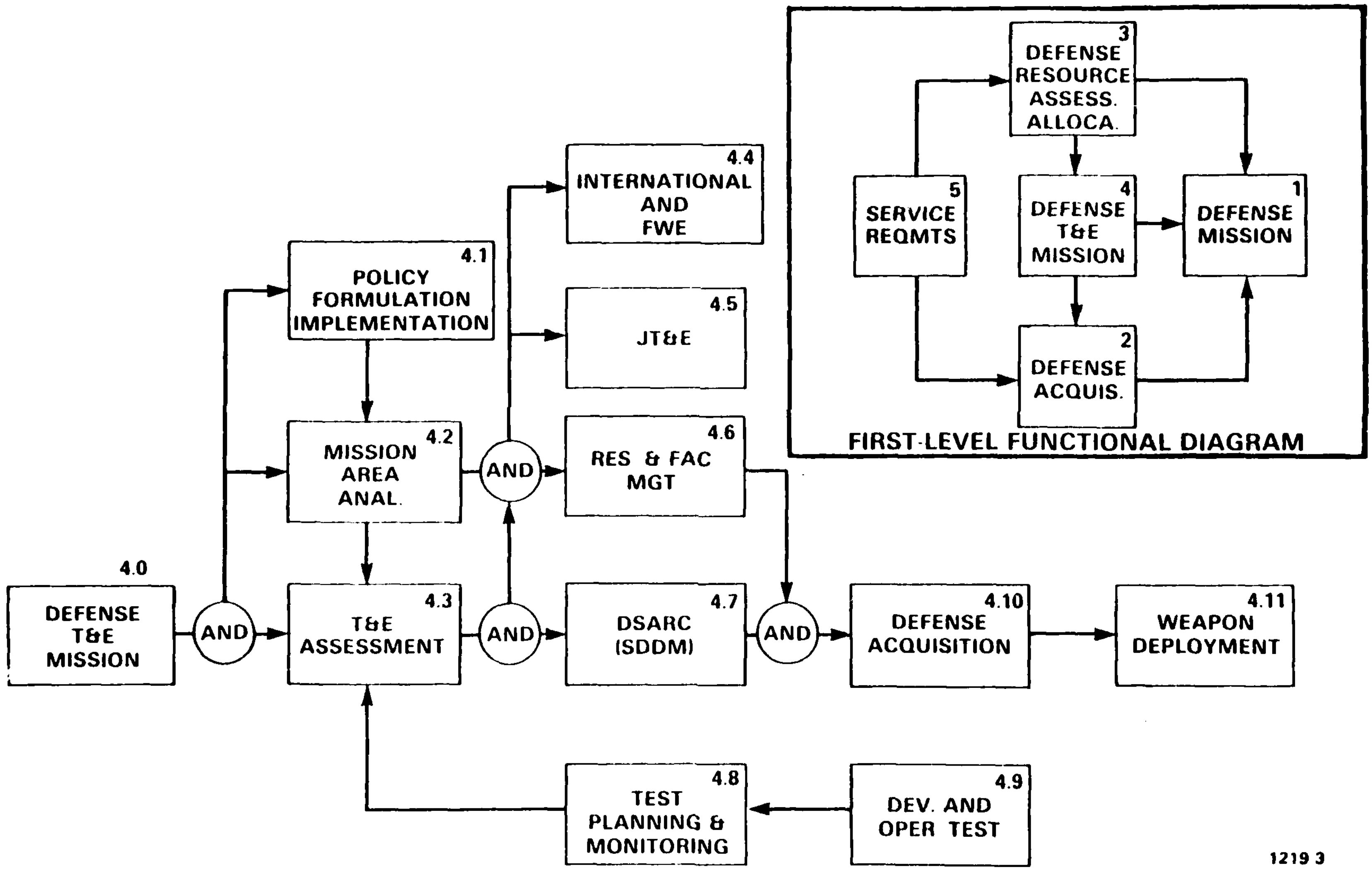
OBJECTIVE: Primary objective of Defense T&E is to support the acquisition of reliable and effective weapon systems for the operating forces. Director Defense T&E will manage test activities to accomplish the following:

- Provide an assessment of weapon system operational effectiveness and suitability at major milestones to demonstrate that the technical performance specifications have been met and to show that engineering design is satisfactory.
- Support Service Independent Test Agency efforts to maintain strong checks and balances in the acquisition process by testing and evaluating weapon systems in their expected operational environment.

FUNCTIONS:

- Formulate and implement T&E policy.
- Develop and submit to SECDEF, Acquisition Executive and DSARC Principals T&E assessments at major program milestones.
- Direct utilization of resources and management of major DoD Facilities.
- Periodically review and assess developmental test and evaluation (DT&E) and operational test and evaluation (DT&E) for major programs (non-DSARC level).
- Evaluate and approve Test and Evaluation Master Plans (TEMPs).
- Sponsor and fund Joint Operational Test and Evaluation (JOT&E).
- Conduct Mission Area evaluations.
- Manage and fund the Foreign Weapon Evaluation Program.
- Coordinate International T&E Memorandums of Understanding (MOUs) and agreements.

# DEFENSE TEST AND EVALUATION
# SECOND-LEVEL FUNCTIONAL DIAGRAM




1219 3

# POLICY FORMULATION AND IMPLEMENTATION (4.1)

## POLICY

o Each DoD official who has direct or indirect responsibility for the acquisition process shall be guided by the policies and objectives of OMB Circular A-109 for major system acquisitions.

o The SECDEF will be advised by the Defense Acquisition Executive (DAE) in making all of the major decisions.

o DDT&E will monitor testing progress, develop an independent assessment, and report findings to DAE and SECDEF.

o T&E shall begin as early as possible and be conducted throughout the acquisition process to assess and reduce risks and estimate operational effectiveness and suitability.

o Meaningful critical issues, test objectives, and evaluation criteria related to the satisfaction of mission need shall be established before tests begin.

o Successful planning for and accomplishment of T&E objectives will be a key requirement for decisions to commit significant additional resources to a program or to advance it from one acquisition phase to another.

o Dependence on subjective judgement concerning system performance shall be minimized — to the extent possible appropriate test instrumentation will be used to provide quantitative data for system evaluation.

## PROCESS DESCRIPTION

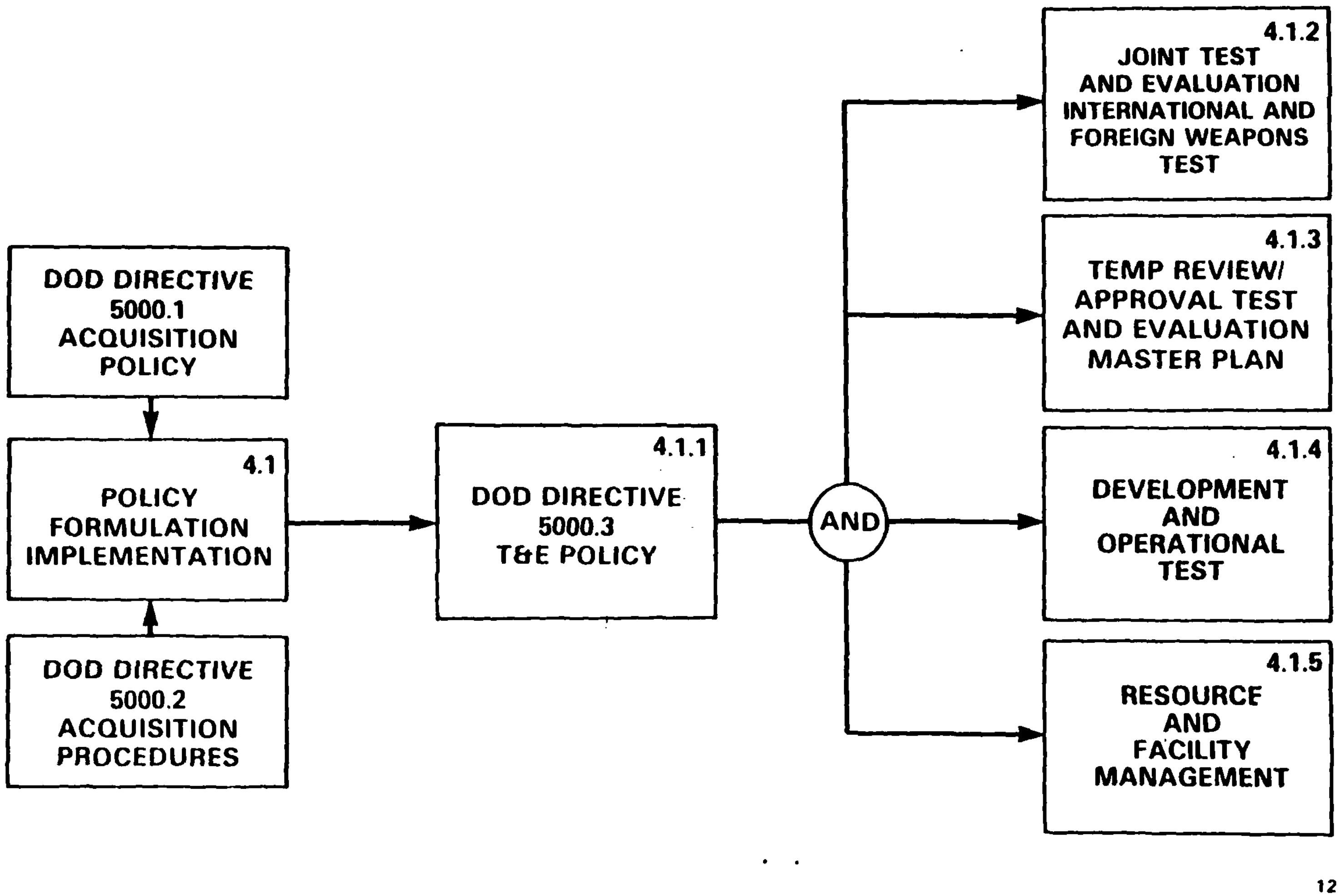
A Service, combining operational need, technical feasibility studies and cost estimates develops the Justification for Major System New Start (JMSNS). This document, coordinated within and approved by OSD, includes

background information and justification for the proposed system. Also, par' of the POM submittal is intended to provide for meaningful reviews of alternatives and to provide for adequate front-end funding of test articles. DDT&E, other than coordination on the JMSNS and subsequent program documents, does not become directly involved in further control until Service submission of the TEMP, which is part of the preparation for DSARC I.

DoDD 5000.3 covers the procedures for development and submission of TEMPs and is the major policy formulation document for DDT&E. This policy is implemented through the major acquisition reviews and procedures described in DoD Directives 5000.1 and 5000.2. In addition, DDT&E enforces and formulates specific requirements through assessment reports to the Secretary of Defense, which are part of the SDDM submission.

Annually, DDT&E conducts a Test Commanders Conference where areas requiring resolution, added emphasis, or coordination are discussed. In addition, DDT&E memoranda may be used for specific requirements or policy of limited duration.

# POLICY FORMULATION AND IMPLEMENTATION THIRD-LEVEL FUNCTIONAL BLOCK DIAGRAM (4.1)



# MISSION AREA ANALYSIS (4.2)

## POLICY

o All OSD offices submit inputs (problem areas, issues, deficiencies and alternative concepts) to respective Mission Area Coordinators (MACs).

o MACs coordinate inputs, develop initial assessments and submit to USDRE (Plans and Development).

o USDRE(P&D) collects inputs and cost alternatives, and develops Mission Area Assessment (MAA).

o USDRE and MRA&L present MAA to the Defense Resources Board (DRB).

o USDRE(P&D) incorporates approved MAA into formulation of the Draft Defense Guidance.

o DRB reviews Draft Defense Guidance.

o SECDEF issues Defense Guidance.

## PROCESS DESCRIPTION

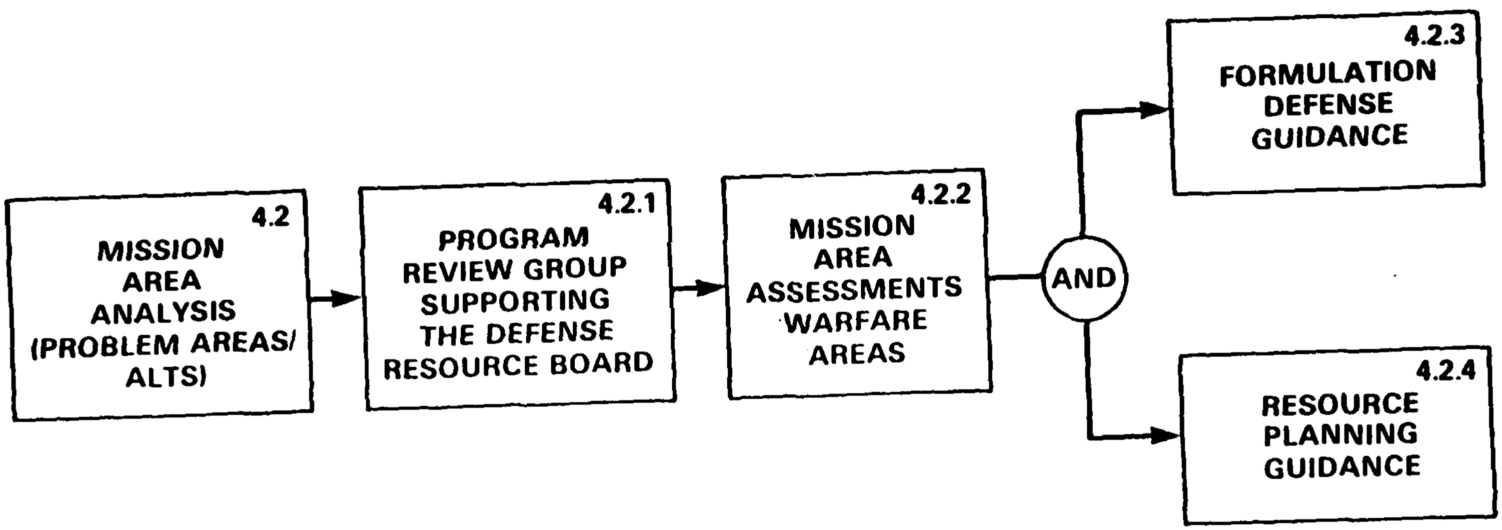
Mission Area Analysis is really a continuing process with the formal analysis done each Fall as OSD develops the Defense Guidance. Certainly the same data is utilized in deciding whether to increase or decrease a program's funding level or whether to ask Congrss for supplemental funds. Nevertheless, in the Fall this process is formalized as each office within OSD is asked, considering the current strategy, to offer problem areas, issues, deficiencies and alternative concepts whereby DoD may achieve itsstated strategy objectives.

DDT&E's input is of primary interest in that this input should highlight program deficiencies, operational effectiveness, and operational suitability. For example, programs must provide adequate front-end funding for early-on testing, i.e., adequate test runs and test hardware. It may be necessary

to consider foreign weapons as alternatives. DDT&E should encourage evolutionary developments as a means of decreasing weapon development time and cost. The resultant analyses are forwarded to a Mission Area Coordinator (MAC) whose task is to combine inputs and develop a program which most cost effectively supports the strategy.

Within USDRE, each MAC then forwards the MAA to USDRE(P&D) where the program is combined and costed to ensure affordability. USDRE(P&D) coordinates the MAA with MRA&L and presents draft MAA to the DRB. The DRB can approve the MAA and forward for inclusion in developing the Defense Guidance or it can provide additional guidance and direct a resubmission.

# MISSION AREA ANALYSIS THIRD-LEVEL FUNCTIONAL DIAGRAM (4.2)



# TEST AND EVALUATION ASSESSMENT (4.3)

## POLICY

o DDT&E will monitor testing progress on a continuous basis throughout the acquisition process and report his independent assessment. Milestone I reviews will evaluate system concepts and alternatives based on specific goals and thresholds established in an approved TEMP. Milestone II reviews will include an assessment of previous by established test plans and test results. Milestone III reviews shall verify operational effectiveness and suitability of major weapon systems.

o T&E assessments shall include the following:

- o Introduction and background on program.
- o Program documentation.
- o Testing accomplished to date.
- o Future testing.
- o Analysis and discussion of issues.
- o Conclusions and recommendations.

o Assessment reporting shall include the following:

- o Summary report to DDT&E.
- o Independent report to DSARC principles.
- o Summary paragraph in the SDDM.
- o Independent summary to DAE and SECDEF.
- o Summary on selected acquisitions to U.S. Congress.
- o Various periodic summary status reports.

## PROCESS DESCRIPTION

Primary inputs utilized in assessments are:

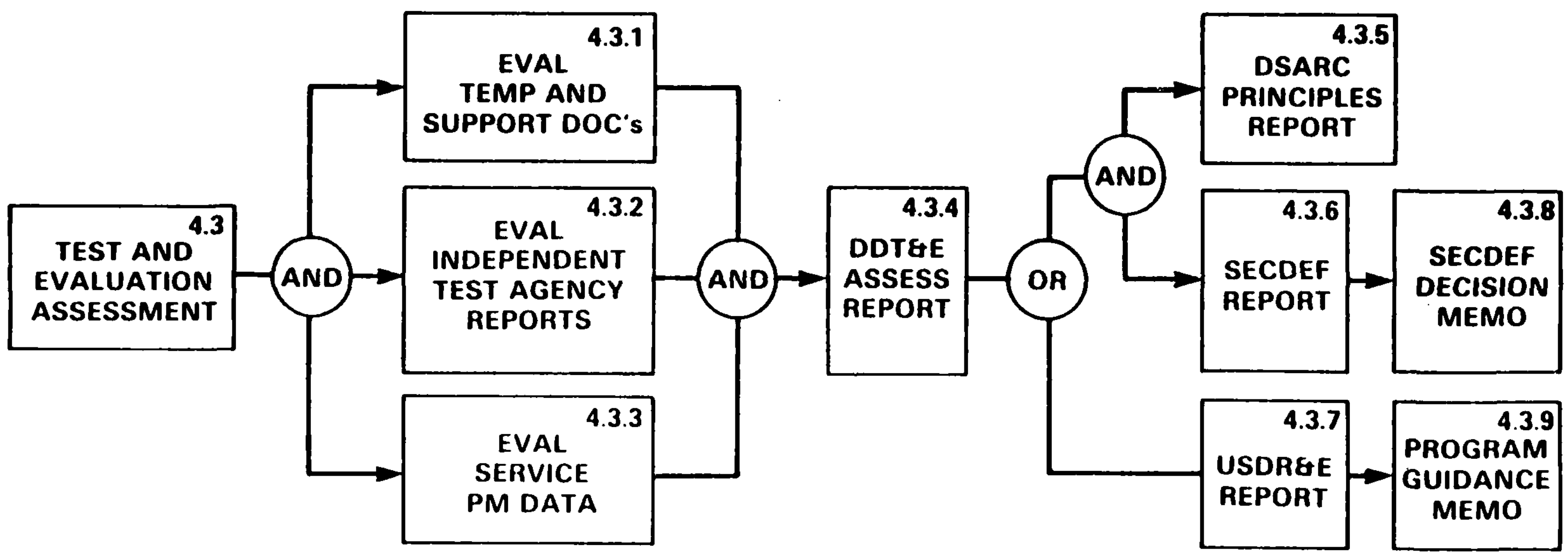
o Test and Evaluation Master Plan (TEMP) and more detailed support documents developed by responsible Service activities.

o Service Independent Test Agency reports and briefings.

o Developmental Test and Evaluation data from Service Program Managers, laboratories, industry developers, etc.

Assessment reports are provided to key decision makers in OSD prior to major program reviews or DSARCs and to the Deputy Secretary of Defense/Secretary of Defense for DSARC level decisions. Critical to successful assessments are reduction of volumes of data distributed over long periods of time to a 6-12 page report that can be further condensed to a 1 to 2 paragraph insertion into an SDDM.

# TEST & EVALUATION ASSESSMENT THIRD-LEVEL FUNCTIONAL BLOCK DIAGRAM (4.3)



# TEST AND EVALUATION ASSESSMENT (4.3)
# RAS — SUMMARY DATA FORM

| REQUIREMENTS ALLOCATION SHEET | FUNCTIONAL DIAGRAM T&E ASSESSMENT 4.3 | | | | | |
|---|---|---|---|---|---|---|
| | CRITICAL TEST ISSUES | | ASSESSMENT CRITERIA | | | |
| FUNCTION NAME & NUMBER | IDENTIFIED IN TESTING TO DATE | IDENTIFIED FOR FUTURE TESTING | PERFORMANCE GOAL/THRESHOLD | FUNCTIONAL ELEMENT | SYSTEM IMPACT | RISK |
| | | | | | | |

# INTERNATIONAL AND FOREIGN WEAPON EVALUATION (4.4)

## POLICY

o Equipment procured for U.S. Forces employed in Europe under the terms of the North Atlantic Treaty should be standardized or at least interoperable with equipment of other members of NATO.

o Priorities for the DoD are established annually in the consolidated guidance. In addition, five top priority areas for interoperability and standardization have been established by the JCS and endorsed by the NATO Military Committee.

o Interoperability and standardization must be considered in meeting worldwide requirements.

o Three major U.S. approaches:

o Establishment of general and reciprocal procurement Memoranda of Understanding (MOU) with NATO member nations.

o Negotiation of dual production of developed or nearly developed systems.

o Creation of families of weapons (program packages) for systems not yet developed.

o Fundamental to the success of the three major U.S. approaches is the improvement of the management structure for arms cooperation within the Alliance.

o DoD shall not normally enter government-to-government offset procurement agreements with other nations.

Appropriate arrangements are to be made to exchange cost data between prospective government participants.

o Commercial implications of technology transfers proposed in support of a collaborative project should be considered when weighing the costs and benefits of that project.

o In general, the U.S. shall permit sales and transfers by NATO allies - - -.

o DoD components shall encourage the transfer of technology - - -.

o General and reciprocal procurement MOU's can provide for broad access of signatory nations to each other's acquisition processes.

o The DoD may reduce or waive various FMS charges - - -.

o Arrangements for NATO industrial participation are encouraged.

o NATO standardization and interoperability are basic goals to be included in acquisition programs.

PROCESS DESCRIPTION

A three phased evaluation procedure is normally followed for Foreign Weapon Evaluation (FWE). Phase I consists of the identification of foreign systems which may satisfy a Service requirement. Phase I evaluation is normally initiated by a user requirement document or a NATO standardization agreement (STANAG). Phase I FWE may also be initiated through liaison officers and foreign unsolicited proposals. In the absence of a Service requirement, the effort will be terminated. If there is a requirement but no approved requirement document, a requirement document will have to be prepared and a full capability search conducted to identify other potential candidates. The list of potential candidates may include both foreign and U.S. systems. This list, based upon available information, should contain descriptions of the potential candiates, provide comparisons of performance parameters with the requirements, and provide unit cost and status of the systems. The list is coordinated with the appropriate interested agencies (Service headquarters for final approval in the proceedings of an Army In-Process Review, Air Force Program Management Directive (PMD) or Navy CNO Evaluation Board (CEB) decision.

If the decision at Service headquarters is to approve Phase I and continue into Phase II, the development command becomes the coordinator for the evaluation effort. An evaluation coordination working group (ECWG) is established and chaired by the development coordinator, consisting of the user's representative, the logistician, developer, trainer, operational evaluator, and development evaluator. As part of Phase II, foreign governments and/or industries are contacted to apprise them of U.S. interest and to ascertain if the foreign governments and industries are willing to cooperate in the program. The test issues are prepared by the appropriate evaluating agencies and submitted to the ECWG. The test issues are used by developmental and operational testers to identify the data requirements and prepare an evaluation plan. The data search results are submitted to the ECWG for a decision as to whether the data are sufficient for preparation of a final report by the evaluators. If data gaps exist, test items are obtained from the foreign governments by way of loan, lease or purchase; test plans prepared, and limited developmental and/or operational tests conducted. If testing is expected to be outside the original design envelope (for instance, in extreme cold and hot weather conditions), it is advisable to purchase the test items so special requests to the foreign developer, with his veto authority, are not required, and repair/refurbishing is not required to the test items. Developmental and operational testing will normally be combined or integrated for Phase II. At the end of the testing and evaluation phase, test reports are prepared and Service approval sought, for one of the following options:

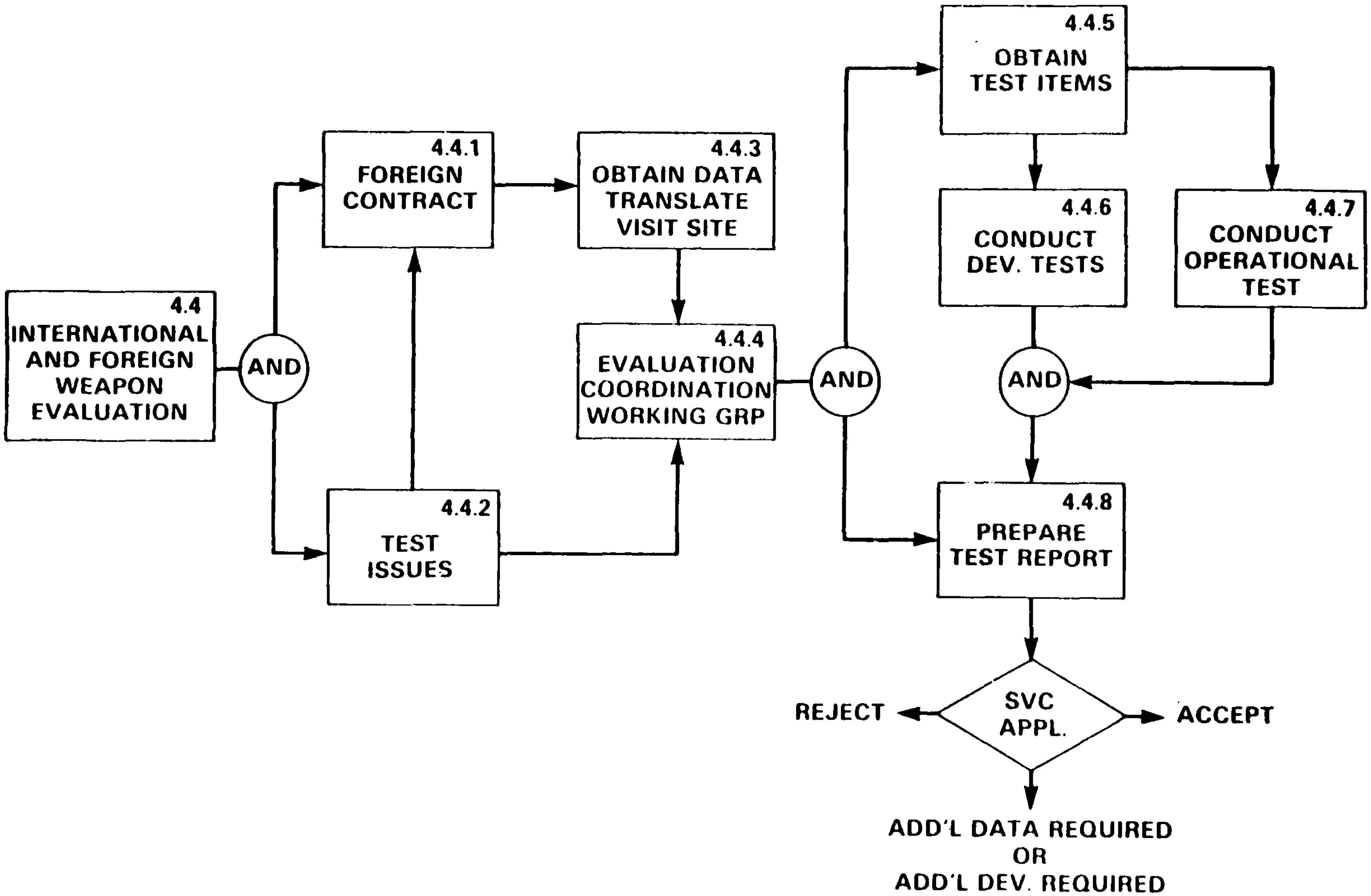
(1) To accept the item as meeting U.S. requirements and to acquire the item by direct buy or co-production.

(2) To reject all items and terminate the effort.

(3) To continue to monitor development of the item or items by the foreign country.

(4) To acquire additional data by proceeding with an additional phase for one or more foreign items.

# INTERNATIONAL AND FOREIGN WEAPON EVALUATION THIRD-LEVEL FUNCTIONAL BLOCK DIAGRAM (4.4)



# JOINT TEST AND EVALUATION (4.5)

## POLICY

o Joint Test and Evaluation (JT&E) may be initiated by DDT&E to accomplish the following:

o Examine capability of developmental and deployed systems to perform intended missions.

o Provide information for technical concepts evaluation, system requirements, system improvements, system interoperability, force structure planning, developing or improving testing methodologies and obtaining information pertinent to doctrine, tactics, and operational procedures for joint operations.

o Responsibility for managing the practical aspects of each JT&E will be delegated to a specific DoD component and supported by forces and material from participating components.

o Control and OSD sponsorship of JT&E will be exercised by the DDT&E.

o The Military Services, Commanders in Chief (CINC) of the Unified and Specified Commands, and Joint Chiefs of Staff may nominate, participate and monitor JT&E as appropriate.

## PROCESS DESCRIPTION

When required and as initiated by the DDT&E, JT&E will be conducted. In addition to examining the capability of developmental and deployed systems to perform their intended mission, JT&Es may also be conducted to provide information for technical concepts evaluation, system requirements, system improvements, systems interoperability, force structure planning, developing or improving testing methodologies, and obtaining information

pertinent to doctrine, tactics, and operational procedures for joint operations. Testing shall be accomplished in realistic operational conditions, when feasible and essential to the evaluation. Responsibility for managing the practical aspects of each JT&E will be delegated to a specific DoD Component, and supported by forces and material from participating Components.

As the proponent for joint procedures and interoperability of deployed forces, the JCS have a requirement for JT&E results that provide information on joint doctrine, tactics, and operational procedures. Joint testing objectives will be addressed, when feasible, in conjunction with scheduled JCS exercises to minimize resource impact and provide economies. When JT&E and JCS exercises are integrated, the JCS will participate, as appropriate, in testing involving joint force interoperability to ensure compatibility of exercise and JT&E objectives.

a. The JCS shall annually coordinate, for submission to the DDT&E, JT&E nominations by the Joint Staff, the Military Services, and the Commanders in Chief (CINC) of the Unified and Specified Commands. This does not preclude direct nominations to the DDTE from the Military Services or CINCs for JT&E activities that are inappropriate for JCS consideration or out of phase with the JCS nominations.

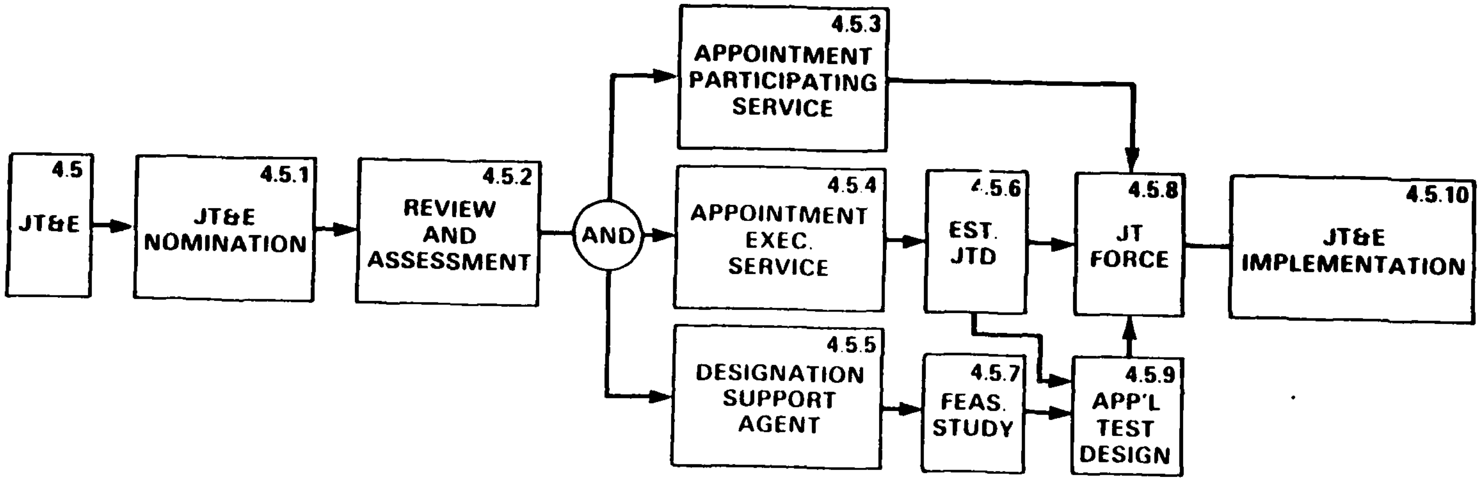
b. The list of nominations shall be prioritized for each fiscal year. To the extent feasible, it shall identify the participating Military Services, identify tests with potential for integration with JCS exercises, and recommend a lead Service or CINC to conduct the JT&E.

c. Control and OSD sponsorship of JT&E will be exercised by the DDTE. The DDTE, in coordination with the JCS, will task the selected lead Service or, through the JCS, the selected CINC to conduct the test, incorporate the test into joint exercises, as appropriate, appoint a

Joint Test Director, develop the test plans, and provide reports, as required.

d. The Military Services, CINCs (if appropriate), and the Joint Staff shall participate in or monitor the JT&E definition and test design efforts, and coordinate the results of these before the commitment of resources.

# JOINT TEST & EVALUATION (JT&E)
# THIRD-LEVEL FUNCTIONAL BLOCK DIAGRAM (4.5)



# JOINT TEST AND EVALUATION (4.5)
# RAS — SUMMARY DATA FORM

| REQUIREMENTS ALLOCATION SHEET (RAS) | | FUNCTIONAL DIAGRAM JT&E 4.5 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | CRITICAL ISSUES/PROBLEMS | | | | BASIC REQUIREMENTS | | | | |
| FUNCTION NAME & NUMBER | RELATIVE MERITS | ALT. S RISKS | ORGAN'L CAP. VER. | FEAS. VERIF. | SVC RESOURCE COMMIT. | WEAPON SYSTEM | SIMULATION MODEL | FUNCTIONAL SYSTEM | MISSION | PERSONNEL |
| 4.5.1 | X | | | | | | | | | |
| 4.5.2 | | X | | | | | | | | |
| 4.5.3 | | | X | X | X | | | | | |
| 4.5.4 | | | X | X | X | | | | | |
| 4.5.5 | | | X | X | | | | | | |
| 4.5.6 | | | | X | X | | | | | |
| 4.5.7 | | | X | X | | X | X | X | X | X |
| 4.5.8 | | | | | | X | X | X | X | X |
| 4.5.9 | | | | | | X | X | X | X | |
| 4.5.10 | | | | | | X | X | X | X | X |

NOTE: CONVERT (X) TO DEFINITIVE FIGURES IN ACTUAL PROGRAM RAS

# RESOURCES AND FACILITIES MANAGEMENT (4.6)

## POLICY

o The Major Range and Test Facility Base (MRTFB) is a national asset which shall be sized, operated, and maintained primarily for DoD test and evaluation support missions, but also be available to all users having a valid requirement for its capabilities.

o Scheduling of test resources shall be based on a priority system that gives equitable consideration to all DoD Components.

o Major MRTFB test and evaluation support capabilities shall be based on a combination of user requirements and the mission of the activity and shall not be duplicated elsewhere within the DoD.

o When a test requires the support of more than one MRTFB activity, a lead MRTFB activity concept shall be used.

o The Major Range and Test Facility Committee shall act as a permanent organization to coordinate planning and actions with respect to the MRTFB.

## PROCESS DESCRIPTION

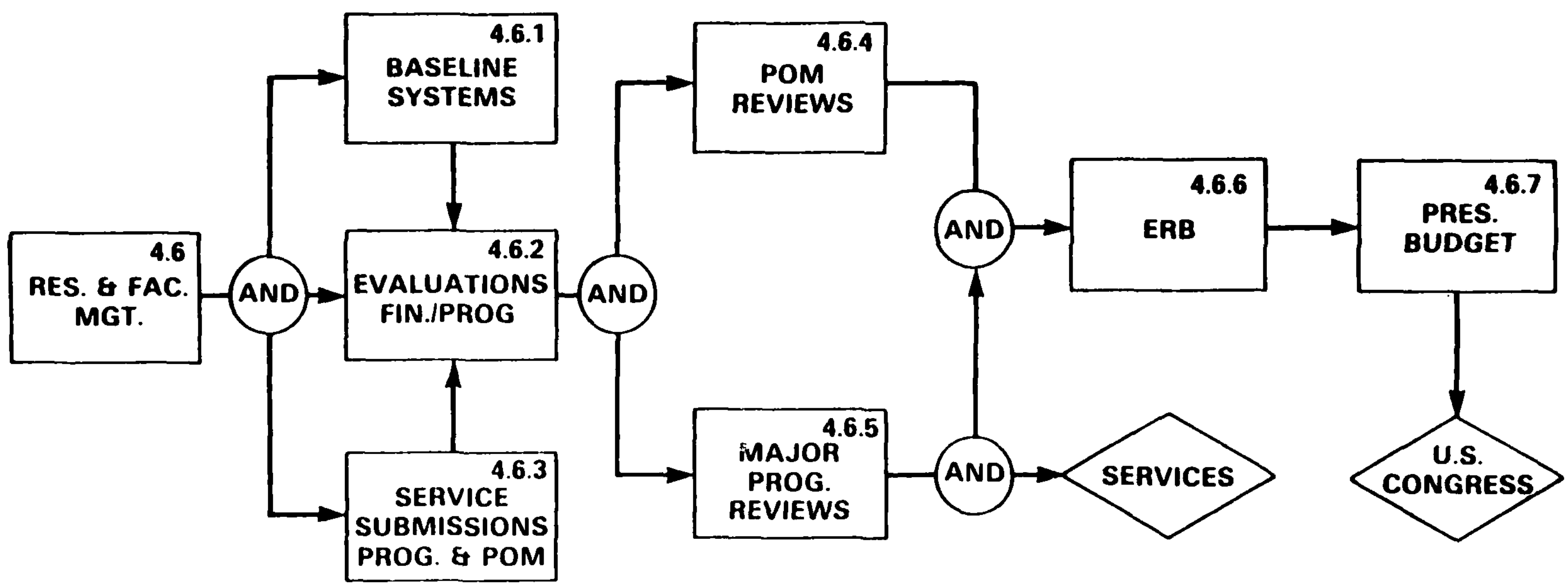
o Test and evaluation support activities within the MRTFB are defined by an iterative process initiated by a program manager having a requirement for such support. The program's T&E needs are stated in a program introduction document, which is provided by the program manager to the test range or ranges best suited to support the program from the standpoint of instrumentation, personnel, airspace and environmental considerations, etc. This document supplies a greater degree of detail on test resource requirements than that outlined in the program TEMP (required by DoD Directive 5000.3). The test requirements are reviewed by the range, which returns to the program manager an assessment of the range's capabilities to provide

the desired support, including perhaps a list of constraints and deficiencies, such as additional instrumentation needed to support the test but not presently available. The program manager evaluates the range capability assessment and supplies the range with a restatement of support needs, possibly revised to accommodate any significant restrictions imposed by limitations on range capability. (Alternatively, the program manager may agree to provide for enhancements to range resources to overcome the restrictions, e.g., a better instrumentation radar or an improved telemetry system.) This interchange is repeated until it converges to an agreement on the type, scope, schedule and funding arrangements for the specified test support.

o According to the DoD Uniform Funding Policy for MRTFB elements, benefitting programs are obliged to reimburse test ranges for the "direct" or "user" costs of test support provided.

o In addition, each range receives "indirect" or "institutional" funding from its parent Service to support improvement and modernization efforts (general maintenance and repair, acquisition of new technology, etc.) and to cover expenses not directly attributable to the requirements of any particular program user. Such funding is monitored from a joint Service perspective by the DDT&E to insure that no unwarranted duplication of range resources is developed, while at the same time deficiencies in MRTFB capability are adequately addressed.

# DEFENSE TEST AND EVALUATION – RES. & FAC. MGT.
# THIRD-LEVEL FUNCTIONAL BLOCK DIAGRAM (4.6)



# DEFENSE SYSTEM ACQUISITION REVIEW COUNCIL (DSARC) (4.7)

## POLICY

o Normally, the DAE will be assisted by the DSARC at Milestones I, II, and III*. Program reviews may be called at any time during the process with OSD staff maintaining continuous visibility over matters such as costs, supportability, test and evaluation.

o OSD and component level milestone reviews shall be scheduled with reasonable proximity.

o Goals and thresholds for cost, schedule, performance, and supportability shall be documented in program documents (JMSNS, SCP, DCP, IPS and TEMPs) and reaffirmed in Secretary of Defense Decision Memorandum (SDDM).

o Milestone I is based on System Concept Papers that will identify program alternatives with specific goals and objectives to be met and reviewed at Milestone II. A TEMP is required prior to Milestone I.

o At Milestone II firm design-to-costs requirements shall be established. Program accomplishments shall be evaluated against cost, schedule, performance and supportability goals and thresholds.

*Milestone III delegated to DoD components for most programs.

## PROCESS DESCRIPTION

The policy, objectives, resources and control procedures to be included in Milestone I, II, and III reviews are specified in JMSNS, DCP, IPS and TEMP documents. The Under Secretary of Defense for Research and Engineering is the Acquisition Executive and is Chairman of the DSARC. Detailed assessment reports and briefings are the primary inputs reviewed by the council, whose basic outputs are recommendations for Secretary of Defense

Decision Memorandum (SDDM). Reaffirmation of mission needs and stated advanced development courses of actions, including management constraints, are established at Milestone I. Performance, cost and schedule thresholds are definitized and a decision rendered on full scale development at Milestone II. Approval of the system for production is accomplished at Milestone III. Usually this is a most difficult stage for T&E with limited operational test data being a primary consideration. Therefore, incremental or conditional decisions are frequently rendered for transition of programs from development to production with subsequent reviews either by DDT&E or the DSARC.

# TEST PLANNING AND MONITORING

## POLICY

o DoD components will structure an effective test program and provide an evaluation of the planned development and operational test program at the major program milestones.

o DDT&E will monitor testing progress and report his independent assessment to DAE and the Secretary of Defense as required.

o Because of the need to reduce acquisition time, the maximum amount of test information obtainable must be collected as early as possible in the acquisition cycle.

o Adequate and early funding of test hardware will be closely examined prior to and at milestone, program, and budget reviews.

o Sufficient resources shall be provided for early initiation and timely completion of T&E. Early and imaginative planning will be required and should be reflected in the Test and Evaluation Master Plan (TEMP). This shall be the primary document utilized in the test planning and implementation process.

## PROCESS DESCRIPTION

The TEMP is the primary document utilized to guide and control T&E. Basic to successful utilization of this document is development and preliminary approval early in the program (prior to Milestone I) with iterative changes encouraged throughout the acquisition to accommodate refinement of data elements. Such an approach establishes achievable stepped demonstrations. It does not mean, as some would imply, that critical requirements and thresholds are rubberized. Basic contents of the TEMP include:

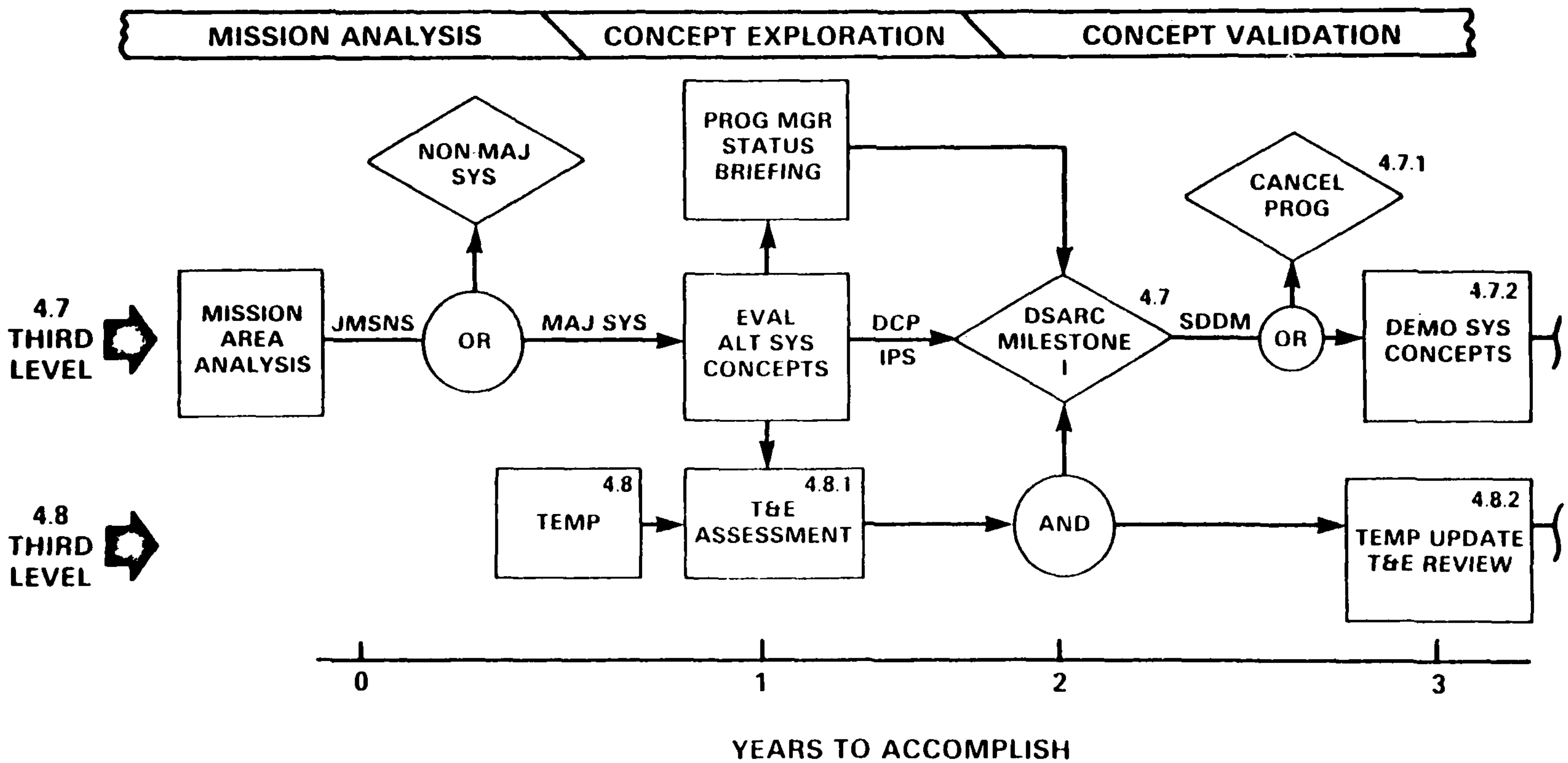
o Mission and System Description;

- Required operational and technical characteristics;
- Critical T&E issues;
- Management responsibilities;
- DT&E/OT&E expected or actual results;
- Production acceptance T&E;
- Test articles and special support requirements.

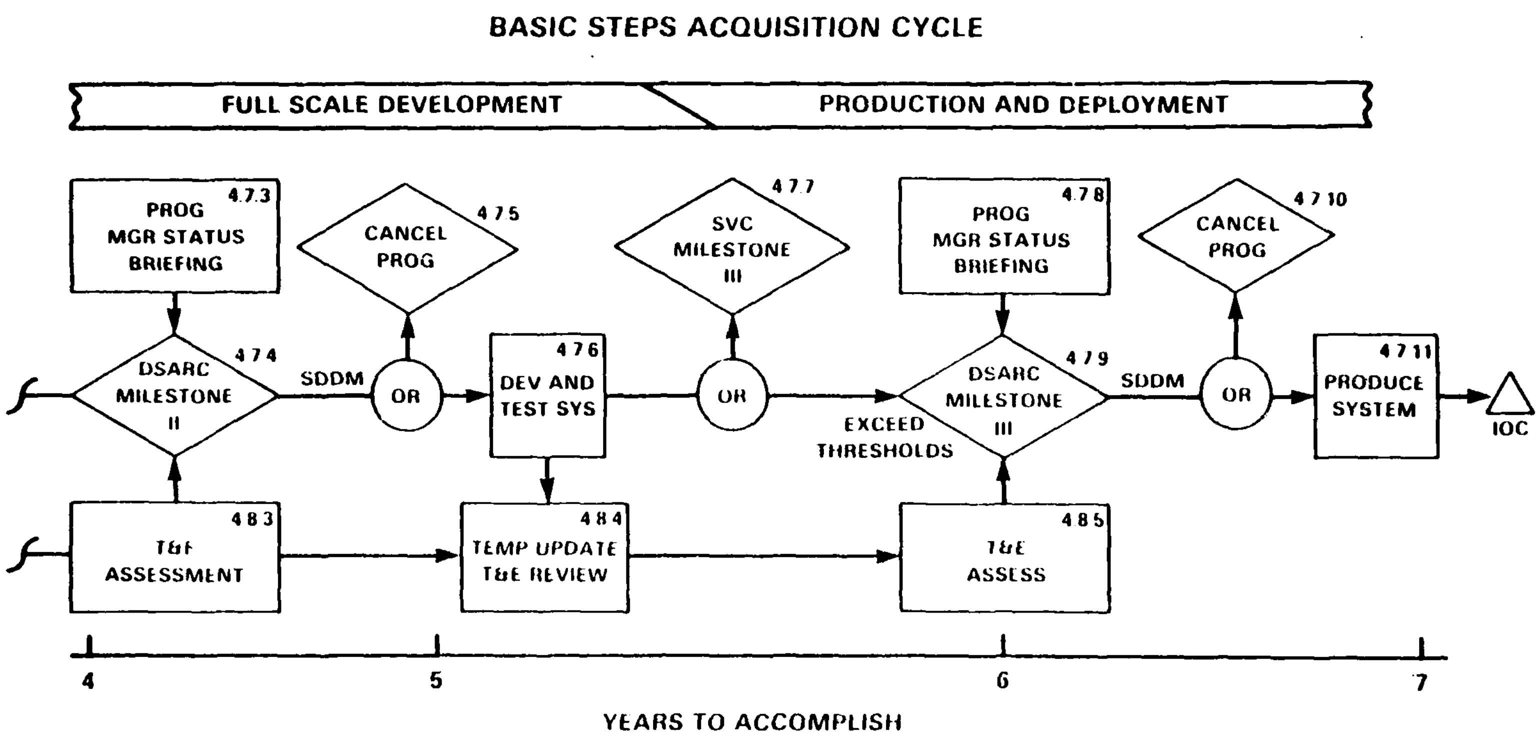
Perhaps the most important part of this process is the implementation procedures specified in hiearchical test plans. For example, it is essential to have critical data specified in higher level plans included in procedures utilized at the extremities of the test organization e.g., the knee cards of pilots flying the aircraft in the case of the B-1 program.

# TEST PLANNING AND MONITORING/DSARC THIRD-LEVEL FUNCTIONAL DIAGRAM (4.7 & 4.8)

## BASIC STEPS ACQUISITION CYCLE



# TEST PLANNING AND MONITORING/DSARC THIRD-LEVEL FUNCTIONAL BLOCK DIAGRAM (4.7 & 4.8)



# DEVELOPMENT AND OPERATIONAL TEST (4.9)

## POLICY

o The head of each DoD component shall designate a single major field agency, separate and distinct from the material developing/processing commands and user representative commands, to be responsible for the conduct of operational test and evaluation (OT&E).

o DT&E will be accomplished by DoD Components to assist the engineering design and development process and to verify attainment of technical performance specifications and objectives. Such T&E shall include participation of the DoD component's independent test activity and support decisions required at major program milestones.

o OT&E shall be conducted by a DoD component's independent test activity to determine the operational effectiveness and suitability characteristics of the system in the acquisition cycle. An independent assessment shall be issued by these activities.

o Combining development and operational testing is permitted under the special provision of DoD policy, provided credibility of independent OT&E is maintained, an acquisition approach is established early and approved by SECDEF, and a clear testing methodology has been established in an approved TEMP.

o Production Acceptance Test and Evaluation (PAT&E) shall be validated by the DoD components as part of their acquisition responsibilities.

## PROCESS DESCRIPTION

The two principal types of test and evaluation conducted in the acquisition process are Development Test and Evaluation (DT&E) and Operational Test and Evaluation (OT&E). DT&E is conducted by or under

the supervision of the development agency to evaluate technical performance of prototype equipment. This testing is generally conducted by engineers and technicians—either contractor or government—in carefully controlled conditions. OT&E, on the other hand, is conducted exclusively by military personnel to determine the degree to which new equipment fulfills military operational requirements. It is, as a rule, conducted under conditions that duplicate as closely as possible the environment in which the equipment is expected to perform when deployed.

These assessments serve important functions in the acquisition process. DT&E assists in the actual design and development of a system in which initial designs are converted to hardware. An iterative process of test, note deficiencies, alter design, modify hardware—"cut and try"—provides the necessary feedback for an orderly progression from initial design through engineering model stages to production prototype. Additionally, DT&E provides information on the progress of new system development. The progress is ascertained by comparing measured system performance with a set of technical goals and objectives for the program. A principal contribution of DT&E, especially prior to full-scale engineering development phases, is the assessment of alternative system concepts and technical approaches.

OT&E, like DT&E, also provides essential information for decision-making by comparing system operational performance with operational objectives. Since OT&E conducted before system production involves testing of prototypes—often competing prototypes—test results must be extrapolated to predict the operational performance and suitability of the final system.

Combined DT&E and OT&E are often conducted, especially in the development of large, expensive systems or systems which will have a small number produced and fielded.

Production Acceptance Test and Evaluation (PAT&E) is the third category of testing, conducted on production items to demonstrate that they meet contract specifications. PAT&E performing agencies and methods are more varied than those conducting pre-production T&E. Developing agencies sometimes are responsible for the conduct of PAT&E. Often the Defense Contract Administrative Service or the Service Plant Representative (e.g., NAVPRO or AFPRO) will conduct PAT&E. In the Navy, acceptance testing of ships and aircraft is the responsibility of the Board of Inspection and Survey.

Each Service maintains a major field agency, separate and distinct from both the developing or procuring activity and the eventual user activity, to be responsible for the conduct of OT&E and the monitoring of DT&E. Each such agency is required to report the results of independent OT&E (normally by Independent Evaluation Report, IER) directly to the Service Chief and to the Director Defense Test and Evaluation for major weapon systems requiring DSARC level reviews. The Services' independent OT&E agencies are as follows:

Army. U.S. Army Operational Test and Evaluation Agency (OTEA), 5600 Columbia Pike, Falls Church, VA 22041

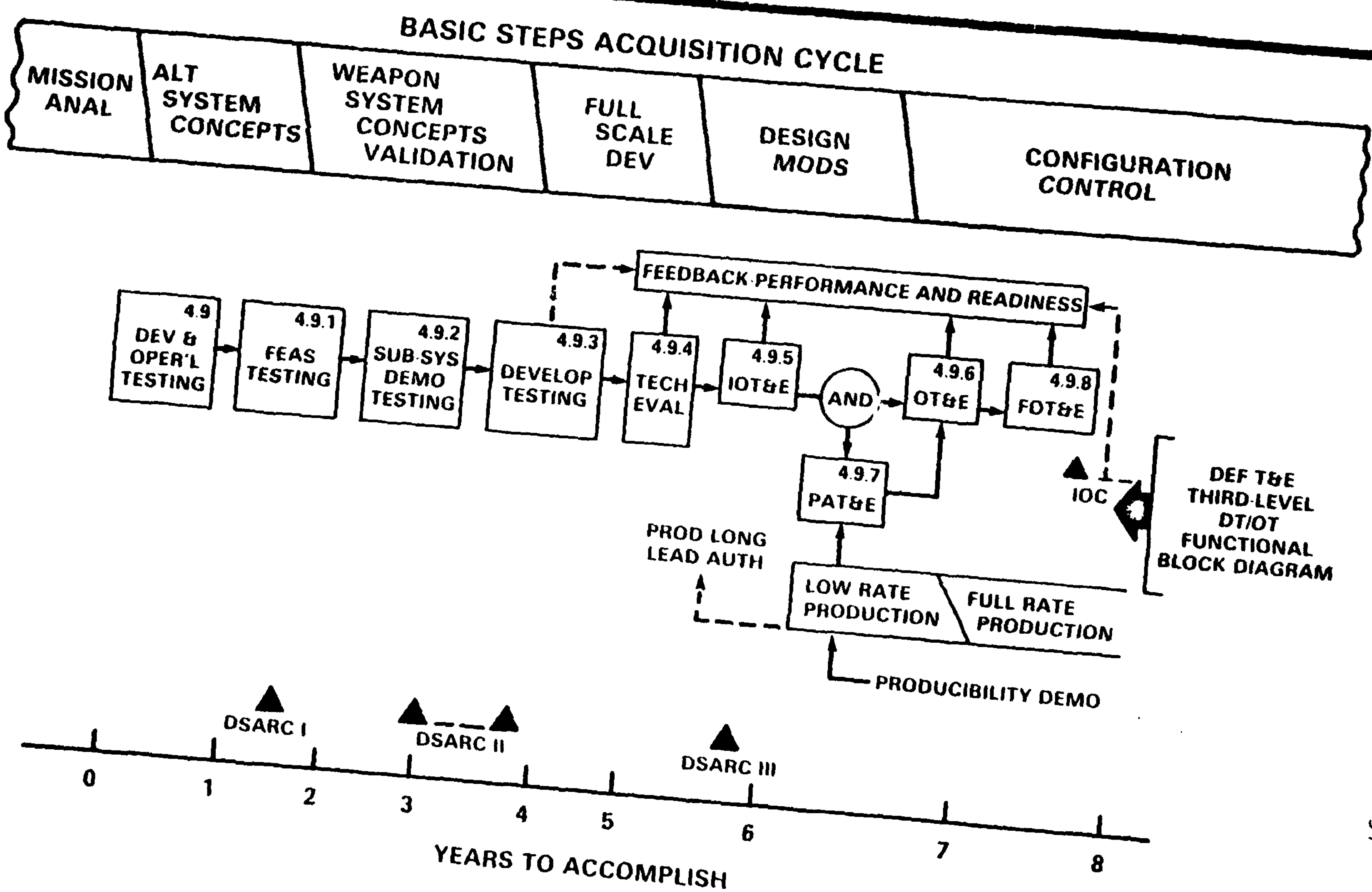
Navy. Commander Operational Test and Evaluation Force, (COMOPTEVFOR), Norfolk, VA 23511.

Air Force. Air Force Test and Evaluation Center (AFTEC), Kirtland Air Force Base, NM 87117.

The foregoing organizations were established by the Services to fulfill the "independent OT&E" requirements of DoD policy. Each Service has other activities that perform testing functions, generally within its materiel development and acquisition structure. These activities

are configured and staffed for technical, that is, development, test and evaluation. These activities are normally specified for particular test support in a program's charter or charter-implementing documentation (e.g., the Test and Evaluation Master Plan (TEMP)) to provide test and/or evaluation support either independently or as monitor agency for contractor DT&E efforts.

## DEVELOPMENTAL AND OPERATIONAL TEST THIRD-LEVEL FUNCTIONAL DIAGRAM (4.9)



# DEVELOPMENTAL & OPERATIONAL TESTING (4.9) — DESIGN SYNTHESIS — DATA FORM

DEFENSE TEST AND EVALUATION

| TEST CYCLE / TEST LEVEL | FEAS TESTING | SUB SYS DEMO TESTING | SYS DEV TESTING | TECH EVAL | INITIAL OT&E | OT&E | PAT&E | FOT&E |
|---|---|---|---|---|---|---|---|---|
| DEVELOP COMPONENTS | X | | | | | | | |
| DEVELOP MODULES | X | X | | | | | | |
| DEV HDW ASSEMBLY | | X | X | | | | | |
| SOFTWARE VERIFICATION | X | X | X | | | | | |
| SYSTEM MODEL/SIM | | | X | X | X | | | |
| LAB INT TEST BED | | | X | X | X | | | |
| LAB FIELD SYS ARTICLE | | | | X | X | | | |
| DEVELOP PROTOTYPE | | | | X | X | | | |
| PROD SUB ASSY | | | | | | | X | |
| SYSTEM PRE PROD | | | | | | X | X | |
| SYS PROD ARTICLE | | | | | | X | X | X |

X INSERT SPECIFIC VALUES

# DEVELOPMENTAL & OPERATIONAL TESTING (4.9) — TRADE OFF ANALYSIS — DATA FORM

| (DESIGNER) SYSTEM PARAMETERS | PERFORMANCE PARAMETERS (USER/TESTER) | | | | | | | | | | | OTHER VARIABLES | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | SYSTEM EFFECTIVENESS | | | | | | SUITABILITY | | | | | | | |
| | RANGE | ACCURACY | ALTITUDE | SPEED | SURVIV-ABILITY | HUMAN FACTORS | MTTR | MTBF | TRAINING | MLTD | AO | SCHEDULE | COSTS | RISKS |
| KEY SYS FUNCTIONS | | | | | | | | | | | | | | |
| TECH'L CHAR'S | | | | | | | | | | | | | | |
| OPER'L CHAR'S | | | | | | | | | | | | | | |
| CRITICAL SYSTEM INTERFACES | | | | | | | | | | | | | | |
| UNIQUE CHAR'S | | | | | | | | | | | | | | |
| CRITICAL TEST ISSUES | | | | | | | | | | | | | | |

# DEVELOPMENTAL & OPERATIONAL TEST (4.9) — SUMMARY DATA FORM

| REQUIREMENTS ALLOCATION SHEET | FUNCTIONAL DIAGRAM DEVELOPMENTAL & OPERATIONAL TESTING 4.9 | | | | | |
|---|---|---|---|---|---|---|
| | BASIS ELEMENTS* | | SUPPORT ELEMENTS* | | | |
| FUNCTION NAME & NUMBER | TEST DESIGN REQMTS (CRITICAL GOALS/ THRESHOLDS) | TEST FACILITY FACILITY REQMTS | SPT EQUIP REQMTS | TEST PLATFORM REQMTS | DATA COLLECTION & EVAL REQMTS | PERSONNEL REQMTS |
| FEAS TESTING | | | | | | |
| SUB SYS DEMO TESTING | | | | | | |
| SYS DEV TESTING | | | | | | |
| TECH EVAL | | | | | | |
| IOT&E | | | | | | |
| OT&E | | | | | | |
| PROD TESTING | | | | | | |
| FOT&E | | | | *TAY' ?R TO SPECIFIC PROGRAMS | | |

DEFENSE ACQUISITION (4.10)

OLICY

o Improved readiness and sustainability are primary objectives of the acquisition process and operational suitability of deployed weapon systems is an objective of equal importance with operational effectiveness.

o An acquisition strategy will be developed at the inception of each major acquisition.

o Minimizing the time it takes to acquire material and facilities to satisfy military needs shall be a primary goal in the development of an acquisition strategy.

o Goals and thresholds for cost, schedule, performance, and supportability shall be documented in program documents (JMSNS, SCP, DCP, IPS, & TEMPS) and reaffirmed in Secretary of Defense Decision Memorandum (SDDM).

o Milestone I is based on System Concept Papers that will identify program alternatives with specific goals and objectives to be met and reviewed at Milestone II. A TEMP is required prior to Milestone I.

o At Milestone II (program review and decision for FSD) firm design-to-cost requirements shall be established. Program accomplishments shall be evaluated against cost, schedule, performance and supportability goals and thresholds. FSD decisions must be supported by T&E.

o Threshold values shall be proposed at Milestones I & II by the DoD component and approved by SECDEF for cost, schedule, performance, and supportability.

o Production decisions (Milestone III) must be based on completion of sufficient operational test and evaluation by the Service independent test activity to determine operational effectiveness and suitability.

ND

ATE
LMED

83

TIC